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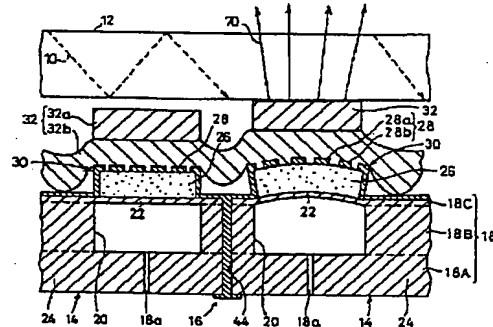
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(54) DISPLAY DEVICE**(57) Abstract:**

PROBLEM TO BE SOLVED: To eliminate the necessity of increasing the number of pixels when the device is applied for a color display system, to reduce the capacitance in an actuator section and to provide display luminance having no irregularity and improved picture quality.

SOLUTION: The device displays the picture corresponding to video signals on an optical waveguide plate 12 by controlling the displacement operations of the contact/separation direction of an actuator section 14 for the plate 12 and controlling scattered beams 70 of a prescribed part of the plate 12. The section 14 consists of an actuator section main body 30 which has a piezoelectric/electrostriction layer 26 and a pair of electrodes 28 formed on a main surface of the layer 26, a vibrating section 22 which is in contact with the other main surface of the layer 26 and supports the body 30 and a fixed section 24 which supports the section 22 in a freely vibrating manner. Moreover, a displacement transferring section 32 is provided to transfer the displacement operations of the body 30 to the plate 12 caused by the voltage application to the electrodes 28.



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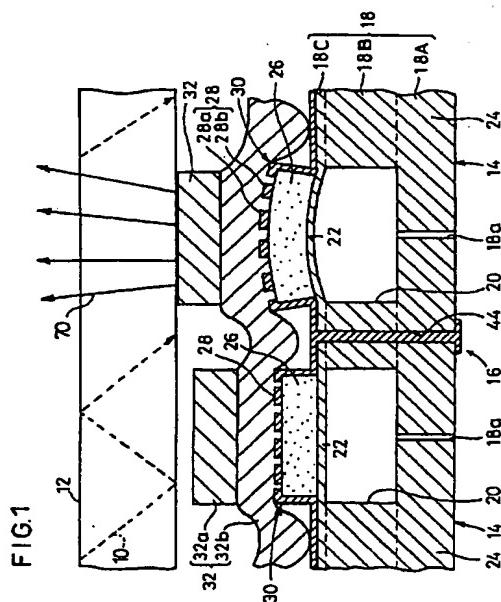
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(54) 【発明の名稱】 表示装置

(57) 【要約】

【課題】カラー表示方式に適用させた場合に画素数を増加させる必要がないという利点に加えて、アクチュエータ部での静電容量を低減でき、表示画面全面に白色を表示させた場合に、むらのない表示輝度及び画質の向上を図る。

【解決手段】光導波板12に対するアクチュエータ部14の接触・離隔方向の変位動作を制御して、光導波板12の所定部位の散乱光70を制御することにより、光導波板12に画像信号に応じた映像を表示させる表示装置において、アクチュエータ部14として、圧電／電歪層26と、該圧電／電歪層26の一主面に形成された一対の電極28とを有するアクチュエータ部本体30と、圧電／電歪層26の他主面に接してアクチュエータ部本体30を支持する振動部22と、該振動部22を振動可能に支持する固定部24を具備して構成し、更に、一対の電極28への電圧印加によって生じるアクチュエータ部本体30の変位動作を光導波板12に伝達する変位伝達部32を設けて構成する。



【特許請求の範囲】

【請求項1】光が導入される光導波板と、該光導波板の一方の板面に対向して設けられ、かつ多数の画素に対応した数のアクチュエータ部が配列された駆動部を具備し、入力される画像信号の属性に応じて前記光導波板に対する前記アクチュエータ部の接触・離隔方向の変位動作を制御して、前記光導波板の所定部位の漏れ光を制御することにより、前記光導波板に前記画像信号に応じた映像を表示させる表示装置において、

前記アクチュエータ部は、圧電／電歪層と、該圧電／電歪層の一主面に形成された一対の電極とを有するアクチュエータ部本体と、

前記圧電／電歪層の他主面に接して前記アクチュエータ部本体を支持する振動部と、

前記振動部を振動可能に支持する固定部とを具備し、

前記一対の電極への電圧印加によって生じる前記アクチュエータ部の変位動作を光導波板に伝達する変位伝達部を有することを特徴とする表示装置。

【請求項2】請求項1記載の表示装置において、

前記振動部及び前記固定部がセラミックスにて一体に形成され、

前記振動部に対応する箇所に空所が形成されて、該振動部が薄肉とされていることを特徴とする表示装置。

【請求項3】請求項2記載の表示装置において、

前記空所及び前記圧電／電歪層の各平面形状が共に角のとれた形状であって、前記空所の平面形状の大きさが圧電／電歪層のそれよりも大であることを特徴とする表示装置。

【請求項4】請求項3記載の表示装置において、

前記空所及び前記圧電／電歪層の各平面形状が共に円形であることを特徴とする表示装置。

【請求項5】請求項3記載の表示装置において、

前記空所及び前記圧電／電歪層の各平面形状が共に長円形状であることを特徴とする表示装置。

【請求項6】請求項3記載の表示装置において、

前記空所及び前記圧電／電歪層の各平面形状が共に矩形状であって、コーナー部が角のとれた形状であることを特徴とする表示装置。

【請求項7】請求項3記載の表示装置において、

前記空所及び前記圧電／電歪層の各平面形状が共に多角形状であって、各頂角部分が丸みを帯びた形状であることを特徴とする表示装置。

【請求項8】請求項1～7のいずれか1項に記載の表示装置において、

前記一対の電極における前記圧電／電歪層上での平面形状は、これら一対の電極が互いに並行に、かつ相互に離間された渦巻き状とされていることを特徴とする表示装置。

【請求項9】請求項1～7のいずれか1項に記載の表示装置において、

前記一対の電極における前記圧電／電歪層上での平面形状は共に、前記圧電／電歪層上の中心に向かって延びる幹部から多数枝分かれした形状を有し、前記一対の電極が、相互に離間されて相補形に配列された形状であることを特徴とする表示装置。

【請求項10】請求項1～9のいずれか1項に記載の表示装置において、

前記一対の電極間に、前記圧電／電歪層の分極方向を反転させる信号を印加し、自発歪みを除去して前記アクチュエータ部を駆動することを特徴とする表示装置。

【請求項11】請求項1～9のいずれか1項に記載の表示装置において、

前記一対の電極間の所定電界の4倍以上の印加電界による前記アクチュエータ部の屈曲変位特性が、基準電界点を中心に非対称であることを特徴とする表示装置。

【請求項12】請求項11記載の表示装置において、

前記基準電界点を基準とし、絶対値が同一で方向が異なる2つの所定電界の4倍以上の電界をそれぞれ印加したときの屈曲変位量をA、Bとしたとき、 $A \geq 1.5B$ の関係を有することを特徴とする表示装置。

【請求項13】請求項11又は12記載の表示装置において、

前記一対の電極に印加される所定の電圧範囲に関し、前記多数のアクチュエータ部のうち、ON選択とすべきアクチュエータ部に対して、前記屈曲変位特性における一方の変位量が最大である方向に電圧を印加することを特徴とする表示装置。

【請求項14】請求項11又は12記載の表示装置において、

前記一対の電極に印加される所定の電圧範囲に関し、前記多数のアクチュエータ部のうち、OFF選択とすべきアクチュエータ部に対して、前記屈曲変位特性における一方の変位量が最小である方向に電圧を印加することを特徴とする表示装置。

【請求項15】請求項11又は12記載の表示装置において、

前記一対の電極に印加される所定の電圧範囲に関し、前記多数のアクチュエータ部のうち、非選択とすべきアクチュエータ部に対して、前記屈曲変位特性における一方の変位量が最小である方向に電圧を印加することを特徴とする表示装置。

【請求項16】請求項1～15のいずれか1項に記載の表示装置において、

前記一対の電極間の距離をx ($1 \mu m \leq x \leq 200 \mu m$)、前記圧電／電歪層の厚みをy ($1 \mu m \leq y \leq 100 \mu m$)としたとき、 $y = ax$ の関係を有し、

かつ、 $1/10 \leq a \leq 100$ であることを特徴とする表示装置。

【請求項17】請求項16記載の表示装置において、

$1/5 \leq a \leq 10$ であることを特徴とする表示装置。

【請求項18】請求項17記載の表示装置において、 $1/2 \leq a \leq 5$ であって、かつ $1 \mu m \leq x \leq 60 \mu m$ 、 $1 \mu m \leq y \leq 40 \mu m$ であることを特徴とする表示装置。

【請求項19】請求項16～18のいずれか1項記載の表示装置において、前記振動部の厚みを z ($1 \mu m \leq z \leq 50 \mu m$) としたとき、 $y = b z$ の関係を有し、かつ、 $1/5 \leq b \leq 10$ であることを特徴とする表示装置。

【請求項20】請求項19記載の表示装置において、 $1/3 \leq b \leq 5$ であることを特徴とする表示装置。

【請求項21】請求項20記載の表示装置において、 $1/3 \leq b \leq 5$ であって、かつ $1 \mu m \leq y \leq 40 \mu m$ 、 $1 \mu m \leq z \leq 20 \mu m$ であることを特徴とする表示装置。

【請求項22】請求項10～21のいずれか1項に記載の表示装置において、前記振動部の中心を通る最短寸法における断面形状が、電圧無負荷状態で以下の条件を満足することを特徴とする表示装置。

(1) 前記固定部に近接する一方の最外極小点と他方の最外極小点とを結ぶことにより構成される基準線より、前記圧電／電歪層の中央部付近における上面の少なくとも一部分が、前記振動部と反対方向に突出していること。

(2) 前記最外極小点が存在しない場合は、前記最短寸法に沿う振動部の上面のうち、前記固定部との境界点に対応する点を最外極小点とすること。

(3) 前記振動部の前記固定部との境界部分を0地点とし、前記振動部の最短寸法長を100としたとき、前記最外極小点が前記0地点から前記振動部における最短寸法長の40%の範囲にない場合は、前記振動部に沿う上面のうち、前記固定部との境界点に対応する点を最小極小点とすること。

【請求項23】請求項22記載の表示装置において、前記突出量 t が、 $m/1000 \leq t \leq m/10$ であることを特徴とする表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、消費電力が小さく、画面輝度の大きな表示装置に関し、特に、入力される画像信号の属性に応じて光導波板に対するアクチュエータ部の接触・離隔方向の変位動作を制御して、光導波板の所定部位の漏れ光を制御することにより、光導波板に画像信号に応じた映像を表示させる表示装置の改良に関するものである。

【0002】

【従来の技術】従来から、表示装置として、陰極線管(CRT)や液晶表示装置等の表示装置が知られている。

【0003】陰極線管としては、通常のテレビジョン受像機やコンピュータ用のモニタ装置等が知られているが、画面は明るいものの、消費電力が大きく、また、画面の大きさに比較して表示装置全体の奥行きが大きくなるという問題がある。

【0004】一方、液晶表示装置は、装置全体を小型化でき、消費電力が少ないと利点があるものの、画面の輝度が劣り、画面視野角度が狭いという問題がある。

【0005】更にこれら陰極線管や液晶表示装置においては、カラー画面にする場合、画素数を白黒画面の3倍にしなければならず、このため、装置自体が複雑になり、消費電力がかさみ、コストアップが避けられないという問題もあった。

【0006】そこで、本出願人は、上記問題を解決すべく、新規な表示装置を提案した(例えば、特開平7-287176号公報参照)。この表示装置は、図30に示すように、画素毎に配列されたアクチュエータ部100を有し、各アクチュエータ部100は、圧電／電歪層102と該圧電／電歪層102の上面及び下面にそれぞれ形成された上部電極104と下部電極106とを具備したアクチュエータ部本体108と、該アクチュエータ部本体108の下部に配設された振動部110と固定部112からなる基体114とを有して構成されている。アクチュエータ部本体108の下部電極106は、振動部110と接触して、該振動部110により上記アクチュエータ部本体108が支持されている。

【0007】上記基体114は、振動部110及び固定部112が一体となってセラミックスから構成され、更に、基体114には、上記振動部110が薄肉になるよう凹部116が形成されている。

【0008】また、アクチュエータ部本体108の上部電極104には、光導波板118との接触面積を所定の大きさにするための変位伝達部120が接着されている。図30の例では、上記変位伝達部120は、アクチュエータ部100が静止しているOFF選択あるいは非選択状態において、光導波板118に近接して配置され、ON選択状態において上記光導波板118に光の波長以下の距離で接触するように配置されている。

【0009】そして、上記光導波板118の例えば端部から光122を導入する。この場合、光導波板118の屈折率の大きさを調節することにより、全ての光122が光導波板118の前面及び背面において透過することなく内部で全反射する。この状態で、上記上部電極104及び下部電極106を通してアクチュエータ部100に画像信号の属性に応じた電圧信号を選択的に印加して、該アクチュエータ部100にON選択、OFF選択及び非選択の各種変位動作を行わせることにより、上記変位伝達部120の光導波板118への接触・離隔が制御され、これにより、上記光導波板118の所定部位の散乱光(漏れ光)124が制御されて、光導波板118

に画像信号に応じた映像の表示がなされる。

【0010】この表示装置によれば、(1) 消費電力を少なくできること、(2) 画面輝度を大きくすることができること、(3) カラー画面にする場合において、画素数を白黒画面の場合に比して増加させる必要がないこと、等の利点を有する。

【0011】

【発明が解決しようとする課題】ところで、上記提案例に係る表示装置においては、アクチュエータ部本体108の構成を圧電／電歪層102に上部電極104と下部電極106を形成した、いわゆるサンドイッチ構造としているため、アクチュエータ部本体108での静電容量はどうしても大きくなり、しかも、アクチュエータ部本体108間の配線抵抗との関係で信号伝達上のCR時定数が大きくなるというおそれがある。

【0012】上記CR時定数が大きくなると、画像信号の属性に応じた電圧信号の信号波形になまりが生じ、各電極に規定電圧を印加できないという問題が発生する。これは、圧電／電歪層102に必要な歪みを与えることができないことにつながり、特に、電圧信号が供給される部分から遠い位置に配されたアクチュエータ部100に対応する部位（例えば画面周辺部や中央部等）において、表示輝度が弱くなるおそれがある。

【0013】また、前記提案例に係る表示装置において、サンドイッチ構造のアクチュエータ部本体108、振動部110及び固定部112からなるアクチュエータ部100の屈曲変位特性をみた場合、図31Bに示すように、基準電界点（電界E=0の点）を中心電界の正方向と負方向とで対称形となっている。ここで、屈曲変位は、アクチュエータ部100が一方向（圧電／電歪層102上に形成された上部電極104が自由空間を臨む方向）に対して凸状に変位する場合を正方向、凹状に変位する場合を負方向としている。

【0014】この変位特性は、上部電極104及び下部電極106間に所定電圧を印加し、圧電／電歪層102を分極処理した後、アクチュエータ部100に加えられる電界が例えば+3E→-3E→+3Eの電界となるよう、上部電極104及び下部電極106間に印加される電圧を連続的に変化させたときのアクチュエータ部100の変位をみたものである。

【0015】即ち、アクチュエータ部100に対し、まず、正方向に分極用の電界（例えば+5E）をかけて圧電／電歪層102を分極処理した後、上部電極104及び下部電極106間への電圧印加を停止して電圧無負荷状態とする。そして、測定開始と共に、アクチュエータ部100に周波数1Hz、ピーク値±3Eの正弦波（図31A参照）を印加し、そのときの各ポイント（点A～点D）での変位量をレーザ変位計を用いて連続的に測定する。そのときの測定結果を電界-屈曲変位グラフにプロットしたものが図31Bの特性図である。図31

Bの矢印に示されるように、屈曲変位の変位量は、電界の連続的な増減によって連続的に変化している。

【0016】具体的に、前記測定を電界+3Eから開始したとすると、図32Aに示すように、まず、アクチュエータ部100には、分極方向と同じ方向に電界が印加されることから、圧電／電歪層102は上部電極104及び下部電極106間方向に伸び、上部電極104及び下部電極106と平行な方向に縮みを生ずる。その結果、アクチュエータ部全体は負方向に0.9Δyほど変位する。

【0017】その後、電界を+3Eから-0.5Eに変化させていくと、変位量は徐々に減少していく。電界が負方向になると、図32Bに示すように、分極の向きと反対方向に電界がかかるため、圧電／電歪層102は、上部電極104及び下部電極106と平行な方向に伸びを発生し、変位は正方向へと変化していく。

【0018】次に、-0.5E→-3Eへと電界を変化させていくと、徐々に分極の向きが反転はじめる。即ち、電界の向きと分極の向きがそろいはじめる。図31Bの点B→点c→点Cのうち、点cでほぼ分極が完全に反転していると思われる。その理由は、点c～点C間でヒステリシスがみられないためである。

【0019】そして、図33Aに示すように、電界の向きと分極の向きがそろうことによって、圧電／電歪層102は、水平方向に伸びる状態から縮む状態へと変化していく。電界が-3Eとなった段階では、その変位量は、測定開始時点における変位量(0.9Δy)とほぼ同じになる。

【0020】つまり、分極方向と電界方向が一致した場合、圧電／電歪層102は、電極104及び106の平行方向に縮む（電極104及び106間方向に伸びる）ことになり、これは点A及び点Cの状態が対応する。また、分極方向と電界方向が反対向きの場合、圧電／電歪層102は、電極104及び106の平行方向に伸びる（電極104及び106間方向に縮む）ことになり、これは点B及び点Dの状態が対応する。なお、1E=約1.7kV/mm、1Δy=約1.6μmである。

【0021】その後、電界を-3Eから+0.5Eに変化させていくと、変位量は徐々に減少し、電界が正方向になると、図33Bに示すように、分極の向きと反対方向に電界がかかるため、圧電／電歪層102は、上部電極104及び下部電極106と平行な方向に伸びを発生し、変位は正方向へと変化していく。

【0022】そして、+0.5E→+3Eへと電界を変化させていくと、徐々に分極の向きが反転はじめ、電界の向きと分極の向きがそろうことによって、圧電／電歪層102は、水平方向に伸びる状態から縮む状態へと変化していく。

【0023】このように、前記提案例に係る表示装置におけるアクチュエータ部100においては、屈曲変位特

性が基準電界点（電界E=0）を中心に電界の正方向と負方向とで対称形になっていることから、電圧無負荷状態と電圧印加状態での相対変位量や、互いに逆方向の電界をかけた状態での相対変位量が小さく、アクチュエータ部100に対する制御が困難になるおそれがある。これは、画質の向上を図る上で不利になる可能性があるため、早急にその対策を講じる必要がある。

【0024】本発明はこのような課題を考慮してなされたものであり、カラー表示方式に適用させた場合であっても画素数を白黒画面の場合に比して増加させる必要がないという利点に加えて、アクチュエータ部での静電容量を低減することができるという利点を有し、表示画面全面に白色を表示させた場合に、むらのない表示輝度を得ることができ、画質の向上を図ることができる表示装置を提供することを目的とする。

【0025】

【課題を解決するための手段】請求項1記載の本発明に係る表示装置は、光が導入される光導波板と、該光導波板の一方の板面に対向して設けられ、かつ多数の画素に対応した数のアクチュエータ部が配列された駆動部を具備し、入力される画像信号の属性に応じて前記光導波板に対する前記アクチュエータ部の接触・離隔方向の変位動作を制御して、前記光導波板の所定部位の漏れ光を制御することにより、前記光導波板に前記画像信号に応じた映像を表示させる表示装置において、前記アクチュエータ部として、圧電／電歪層と該圧電／電歪層の一主面に形成された一対の電極とを有するアクチュエータ部本体と、前記圧電／電歪層の他主面に接して前記アクチュエータ部本体を支持する振動部と、前記振動部を振動可能に支持する固定部とを具備させ、前記一対の電極への電圧印加によって生じる前記アクチュエータ部の変位動作を光導波板に伝達する変位伝達部を設けて構成する。

【0026】これにより、まず、光導波板の例えは端部から導入される光は、光導波板の屈折率の大きさを調節することにより、全ての光が光導波板の前面及び背面において透過することなく内部で全反射する。この状態において、光導波板の例えは背面に変位伝達部が光の波長以下の距離で接触すると、それまで全反射していた光は、光導波板の背面に接触している変位伝達部の表面まで透過する。一旦、変位伝達部の表面に到達した光は、変位伝達部の表面で反射して散乱光として、一部は再度光導波板の中で反射するが、散乱光の大部分は光導波板で反射されることなく、光導波板の前面を透過することになる。

【0027】このように、光導波板の背面にある変位伝達部の接触の有無により、光導波板の前面における光の発光（漏れ光）の有無を制御することができる。この場合、光導波板に対して変位伝達部を接触・離隔方向に変位動作させる1つの単位を1画素として考えれば、この画素を多数マトリクス状に配列し、入力される画像信号

の属性に応じて各画素での変位動作を制御することにより、陰極線管や液晶表示装置と同様に、光導波板の前面に画像信号に応じた映像（文字や図形等）を表示させることができる。

【0028】次に、本発明に係る表示装置をカラー表示方式に適用する場合について説明する。まず、人間の色の認識は、視覚神経に残存する三原色の混合によって行われると考えられている。つまり、三原色の混合を行なう現行のカラー表示方式と同様の作用が人間の視覚において行われていることになる。

【0029】これを知って、本発明の発色の原理について説明すると、該発色の原理は、色の三原色であるR（赤）、G（緑）、B（青）の混合方式で規定される。ここで、発色させる周期をTとして、RGBの最大発光時間を3分割することを考える。RGBの発光時間の比率が1：1：1であれば、白色光となり、RGBの発光時間の比率が4：1：5であれば、その比率に応じた中間色になる。従って、発色させる時間の制御は、光導波板と変位伝達部との接触時間を発色させる周期に同期させて、三原色の発光時間を制御してもよいし、三原色の発光時間を発色させる周期に同期させて、光導波板と変位伝達部との接触時間を制御することもできる。

【0030】このようなことから、本発明に係る表示装置においては、カラー表示方式に適用させる場合であっても、画素数を白黒画面の場合に比して増加させる必要がないという利点がある。

【0031】また、本発明に係る表示装置は、変位伝達部を選択的に変位させるアクチュエータ部本体の構成として、圧電／電歪層と、該圧電／電歪層の一主面に形成された一対の電極とを有するようにしている。この場合、一対の電極に所定の電圧が印加されると、圧電／電歪層の一主面において面方向に電界が生じる。なお、この電界の強さは、圧電／電歪層の一主面（表面）が最も大きく、深さ方向に徐々に小さくなる。

【0032】圧電／電歪層はその一主面の面方向に発生した電界に応じて伸びを生じるが、圧電／電歪層をその他主面において支持する振動部には伸びは生じないため、圧電／電歪層の一主面と他主面とで歪みに違いが生じ、その結果、圧電／電歪層は一主面側を凸とした弾性変形が生じる。この圧電／電歪層の凸状の弾性変形によって変位伝達部が光導波板側に変位し、上述したような光導波板からの漏れ光の発生を誘起する。

【0033】本発明に係る表示装置においては、圧電／電歪層の一主面側に一対の電極が形成されて、一対の電極間に空気又は変位伝達部の構成材料（圧電／電歪層と比して誘電率が非常に小さい）が介在することとなるため、アクチュエータ部本体の静電容量は小さくなり、それに伴って信号伝達上のC.R時定数も小さくなる。即ち、画像信号の属性に応じた電圧信号の信号波形になりますは生じにくくなる。

【0034】これにより、各画素における一対の電極に選択的に規定電圧を印加することが可能となって、各圧電／電歪層に必要な伸びを与えることができ、特に、電圧信号供給部分から遠い位置に配されたアクチュエータ部に対応する部位（例えば画面周辺部や中央部等）において、表示輝度が弱くなるということも抑制される。

【0035】このように、本発明に係る表示装置においては、カラー表示方式に適用させた場合であっても画素数を白黒画面の場合に比して増加させる必要がないという利点に加えて、アクチュエータ部での静電容量を低減することができるという利点を有し、表示画面全面に白色を表示させた場合に、むらのない表示輝度を得ることができ、画質の向上を図ることができる。

【0036】また、例えば製造過程において、圧電／電歪層の一部が絶縁破壊等によってその上の電極の一部と共に消失した場合、圧電／電歪層の補修を行わなくとも消失した電極を補修するだけで十分にアクチュエータ部として機能するため、製造工程の途中において全面作り直し等の無駄をなくすことができると共に、表示装置の歩留まりの向上を達成させることができる。

【0037】上記本発明に係る表示装置において、前記振動部及び前記固定部をセラミックスにて一体に形成し、前記振動部に対応する箇所に空所を形成して、該振動部が薄肉となるようにすれば（請求項2記載の発明）、固定部と振動部を容易に作製することができるようになり、表示装置の製造コストの低廉化を図る上で有利となる。

【0038】また、セラミックスにて構成される基体に空所を設けることによって厚肉の固定部と薄肉の振動部が形成されるかたちとなるため、振動部は圧電／電歪層の伸びに敏感に反応し、電圧信号の変化に対して追従性の高い振動部とすることができる。また、振動部と固定部との境部分の剛性が十分に確保されるため、振動部の振動に伴う上記境部分の疲れによる破壊は発生しにくくなる。

【0039】上記本発明に係る表示装置において、前記空所及び前記圧電／電歪層の各平面形状と共に角のとれた形状とし、前記空所の平面形状の大きさを圧電／電歪層のそれよりも大にしてもよい（請求項3記載の発明）。この場合、振動部と固定部との境部分が空所の平面形状と同様に角のとれた形状となるため、振動部の振動によって発生する応力が局部的に集中するということがなくなり、前記境部分での疲れ限度を向上させることができ、アクチュエータ部の長寿命化、ひいては表示装置の長寿命化を実現させることができる。

【0040】前記空所及び前記圧電／電歪層の各平面形状は共に円形としてもよいし（請求項4記載の発明）、共に長円形状としてもよい（請求項5記載の発明）。また、前記空所及び前記圧電／電歪層の各平面形状は共に矩形状であって、コーナー部が角のとれた形状としても

よいし（請求項6記載の発明）、共に多角形状であつて、各頂角部分が丸みを帯びた形状としてもよい（請求項7記載の発明）。

【0041】この場合、振動部の周縁すべてが固定部に支持されることになり、振動部の周縁部分での疲れ限度が大幅に向上し、アクチュエータ部の長寿命化、ひいては表示装置の長寿命化をより実現させることができる。

【0042】上記本発明に係る表示装置において、前記一対の電極における前記圧電／電歪層上の平面形状を、一対の電極が互いに並行に、かつ相互に離間されて渦巻き状に配線された形状としてもよい（請求項8記載の発明）。この場合、一対の電極に所定の電圧が印加されると、圧電／電歪層の一主面には放射状（等方的）に電界が生じ、そのため、圧電／電歪層は、一主面では放射状（等方的）に伸びが生じる。このとき、圧電／電歪層の深い部分では、表面部分の伸びよりも小さい伸びが放射状（等方的）に生じるか、あるいは縮みが放射状（等方的）に生じ、これにより、圧電／電歪層は効率よくその中心部が凸となるように変位し、しかも、各画素間での変位上のばらつきも少なくなる。

【0043】上記本発明に係る表示装置において、前記一対の電極における前記圧電／電歪層上の平面形状と共に、前記圧電／電歪層上の中心に向かって延びる幹部から多数枝分かれした形状を有し、前記一対の電極が、相互に離間されて相補形に配列された形状としてもよい（請求項9記載の発明）。この場合、前記請求項8記載の発明と同様に、一対の電極に所定の電圧が印加された場合、圧電／電歪層は、一主面では放射状（等方的）に伸びが生じる。このとき、圧電／電歪層の深い部分では、表面部分の伸びよりも小さい伸びが放射状（等方的）に生じるか、あるいは縮みが放射状（等方的）に生じることから、効率よくその中心部が凸となるように変位し、各画素間での変位上のばらつきも少なくなる。

【0044】特に、請求項9記載の発明は、幹部と枝部とに分かれているため、圧電／電歪層の一部、例えば枝部に対応する圧電／電歪層が絶縁破壊等によって該枝部と共に消失したとしても、他に与える影響は非常に小さく、幹部が残存している限り、アクチュエータ部として十分機能することとなる。もちろん、前記消失した電極の枝部を補修するだけで、消失前の機能に戻すことができ、表示装置に対する保守の簡易化を実現できる。

【0045】上記本発明に係る表示装置において、前記一対の電極間に、前記圧電／電歪層の分極方向を反転させる信号を印加することにより、自発歪みを除去して前記アクチュエータ部を駆動するようにしてもよい（請求項10記載の発明）。即ち、アクチュエータ部本体の一対の電極間に電圧信号を与えるごとに、圧電／電歪層の分極方向を反転させる信号（例えば+100V→-100V→+100V→-100Vの交番信号）を印加して、アクチュエータ部を駆動する。この場合、アクチュ

エータ部での変位量を常に高く維持することができる。これは、圧電／電歪層の自発歪み分の変位量を常に付加したかたちで変位が得られるためである。このような状態とすることで、表示装置におけるON/OFF制御が容易となり、画質の向上を図る上で有利となる。なお、圧電／電歪層を上部電極及び下部電極にて挟んだ構造、即ち、サンドイッチ構造では、上記駆動を行っても変位量は大きくならない。

【0046】上記本発明に係る表示装置において、前記一対の電極間の所定電界の4倍以上の印加電界による前記アクチュエータ部の屈曲変位特性が、基準電界点を中心に非対称となるように構成してもよい（請求項11記載の発明）。

【0047】前記屈曲変位特性は、アクチュエータ部本体における一対の電極間に分極用の電圧を印加して圧電／電歪層を分極処理した後、アクチュエータ部に加えられる電界が交番的に変化するように、一対の電極間に印加される電圧を連続的に変化させたときのアクチュエータ部の屈曲変位をしたものであり、この場合の屈曲変位とは、アクチュエータ部が一方向（圧電／電歪層上に形成された一対の電極が自由空間を臨む方向）に対して凸状に変位する場合を正方向、凹状に変位する場合を負方向としている。ここで、前記所定電界とは、圧電／電歪層の一主面（表面）に近い部分の分極の向きが逆電界の印加によって反転する電界をいう。

【0048】具体的には、例えば圧電／電歪層を分極処理するために一対の電極間に例えば正方向に所定電圧をかけると、圧電／電歪層の一主面において面方向に正方向の電界が生じる。圧電／電歪層に発生する電界の強さは、前記一主面が最も大きく、深さ方向に徐々に小さくなる。圧電／電歪層は、前記正方向の電界の発生によって、該電界と同じ方向に分極処理される。その後、例えば一対の電極間への電圧印加を停止して電圧無負荷状態とする。

【0049】そして、アクチュエータ部に加えられる電界が交番的に変化するように、一対の電極間に印加される電圧を連続的に変化させる。このとき、例えば分極処理時に生じていた電界の方向（例えば正方向）と同じ方向に電界が生じている段階においては、圧電／電歪層における分極方向と電界の方向とが一致し、圧電／電歪層の表面近くでは電界が強くかかることから、圧電／電歪層は水平方向に伸びることになる。これによって、圧電／電歪素子本体は、一方向及び他方向のいずれかの方向に変位するものと考えられる。

【0050】その後、一対の電極間に印加される電圧が変化して、アクチュエータ部に分極処理時の電界の方向と逆の方向の電界が発生している段階では、以下のような作用を行うことになる。

【0051】まず、電界が弱い段階では、圧電／電歪層の分極の方向と電界の方向が互いに逆になっており、圧

電／電歪層は、水平方向に縮むこととなる。これによって、アクチュエータ部は、他方向に屈曲変位する。その後、電界が強くなってくると、圧電／電歪層の表面部分の分極が反転しはじめ、圧電／電歪層の表面付近では分極の方向と電界の方向が一致し、圧電／電歪層の深い部分では分極の方向と電界の方向が逆になるという現象が生じる。即ち、圧電／電歪層において、2種類の分極が存在することとなり、擬似的なバイモルフ型の圧電／電歪素子として機能することになる。

【0052】その結果、圧電／電歪層の一主面に近い部分と、振動部に近い部分での歪み方向が互いに逆になり、全体として一方向（圧電／電歪層上に形成された一対の電極が自由空間を臨む方向）に凸状変位し、その変位量は、前記擬似的なバイモルフ的な作用によって非常に大きいものとなる。

【0053】特に、本発明では、その変位特性が基準電界点を中心に電界の正方向と負方向とで非対称形となっていることから、例えば周期的に変化する電界の2つのピーク値におけるそれぞれの屈曲変位量において差が生じる。これにより、電圧無負荷状態と電圧印加状態での相対変位量や、互いに逆方向の電界をかけた状態での相対変位量が大きくなる。従って、表示装置の画素単位に配列されるアクチュエータ部とした場合に、これらアクチュエータ部に対する制御が容易になり、表示装置における画質の向上を図る上で非常に有利になる。

【0054】そして、前記構成において、前記基準電界点を基準とし、絶対値が同一で方向が異なる2つの所定電界の4倍以上の電界をそれぞれ印加したときの屈曲変位量をA、Bとしたとき、 $A \geq 1.5 B$ の関係を有することが好ましい（請求項12記載の発明）。この関係によって、屈曲変位特性として、基準電界点を中心に非対称となる特性を得ることができる。

【0055】また、前記構成において、前記一対の電極に印加される所定の電圧範囲に関し、前記多数の駆動部のうち、ON選択とすべきアクチュエータ部に対して、前記屈曲変位特性における一方向の変位量が最大である方向に電圧を印加し（請求項13記載の発明）、OFF選択あるいは非選択とすべきアクチュエータ部に対して、前記屈曲変位特性における一方向の変位量が最小である方向に電圧を印加するようにしてもよい（請求項14又は請求項15記載の発明）。これによって、ON選択されたアクチュエータ部は一方向に最大変位し、OFF選択あるいは非選択とされたアクチュエータ部は最小変位とされ、ON選択されたアクチュエータ部とOFF選択（あるいは非選択）されたアクチュエータ部において変位上の違いが明確となり、表示画面に表示される画像のコントラストや輪郭を鮮明にさせることが可能となる。

【0056】また、前記構成において、前記一対の電極間の距離をx ($1 \mu m \leq x \leq 200 \mu m$)、前記圧電／

電歪層の厚みを y ($1\mu\text{m} \leq y \leq 100\mu\text{m}$) としたとき、 $y = ax$ の関係を有し、かつ、 $1/10 \leq a \leq 10$ として構成してもよい（請求項16記載の発明）。

【0057】この場合、前記一対の電極間の印加電界による前記アクチュエータ部の屈曲変位特性が、請求項1記載の発明に示すような屈曲変位特性、即ち、基準電界点を中心に非対称となる特性を得ることができる。そのため、この請求項16記載の本発明に係る表示装置においても、前記請求項11記載の表示装置と同様に、画素単位に配列されたアクチュエータ部に対する制御が容易になり、表示装置における画質の向上を図る上で非常に有利になる。

【0058】前記構成において、 $1/5 \leq a \leq 10$ することが好ましく（請求項17記載の発明）、 $1/2 \leq a \leq 5$ であって、かつ $1\mu\text{m} \leq x \leq 60\mu\text{m}$ 、 $1\mu\text{m} \leq y \leq 40\mu\text{m}$ であれば更に好ましい（請求項18記載の発明）。

【0059】また、前記構成において、前記圧電／電歪層の厚み y と前記振動部の厚みを特定した場合、振動部の厚みを z ($1\mu\text{m} \leq z \leq 50\mu\text{m}$) としたとき、 $y = bz$ の関係を有し、かつ、 $1/5 \leq b \leq 10$ とすれば（請求項19記載の発明）、屈曲変位量を増大させることができるとなる。

【0060】前記構成において、 $1/3 \leq b \leq 5$ することが好ましく（請求項20記載の発明）、 $1/3 \leq b \leq 5$ であって、かつ $1\mu\text{m} \leq y \leq 40\mu\text{m}$ 、 $1\mu\text{m} \leq z \leq 20\mu\text{m}$ であれば更に好ましい（請求項21記載の発明）。

【0061】更に、請求項10～請求項21記載の発明において、前記振動部の中心を通る最短寸法における断面形状が、電圧無負荷状態で以下の条件を満足するように構成すれば（請求項22記載の発明）、電圧無負荷状態と電圧印加状態でのアクチュエータ部の相対変位量を大きくすることができるため、表示装置におけるON/OFF制御が容易となり、画質の向上を図る上で有利となる。しかも、作製されたアクチュエータ部に対して必ず一方向への大きな屈曲変位を行わせることができ、表示装置の歩留まりの向上を達成させることができる。

【0062】(1) 前記固定部に近接する一方の最外極小点と他方の最外極小点とを結ぶことにより構成される基準線より、前記圧電／電歪層の中央部付近における上面の少なくとも一部分が、前記振動部と反対方向に突出していること。

【0063】(2) 前記最外極小点が存在しない場合は、前記最短寸法に沿う振動部の上面のうち、前記固定部との境界点に対応する点を最外極小点とすること。

【0064】(3) 前記振動部の前記固定部との境界部分を0地点とし、前記振動部の最短寸法長を100としたとき、前記最外極小点が前記0地点から前記振動部における最短寸法長の40%の範囲にない場合は、前記最短

寸法に沿う振動部の上面のうち、前記固定部との境界点に対応する点を最外極小点とすること。

【0065】特に、請求項22記載の発明において、前記突出量 t を、 $m/1000 \leq t \leq m/10$ とすれば更に好ましい（請求項23記載の発明）。

【0066】

【発明の実施の形態】以下、本発明に係る表示装置の実施の形態例（以下、単に実施の形態に係る表示装置と記す）を図1～図29を参照しながら説明する。

【0067】本実施の形態に係る表示装置は、図1に示すように、光10が導入される光導波板12と、該光導波板12の背面に対向して設けられ、かつ多数のアクチュエータ部14が画素に対応して配列された駆動部16を有して構成されている。

【0068】駆動部16は、例えばセラミックスにて構成された基体18を有し、該基体18の各画素に応じた位置にアクチュエータ部14が配設されている。上記基体18は、一主面が光導波板12の背面に対向するよう配置されており、該一主面は連続した面（面一）とされている。基体18の内部には、各画素に対応した位置にそれぞれ後述する振動部を形成するための空所20が設けられている。各空所20は、基体18の他端面に設けられた径の小さい貫通孔18aを通じて外部と連通されている。

【0069】上記基体18のうち、空所20の形成されている部分が薄肉とされ、それ以外の部分が厚肉とされている。薄肉の部分は、外部応力に対して振動を受けやすい構造となって振動部22として機能し、空所20以外の部分は厚肉とされて上記振動部22を支持する固定部24として機能するようになっている。

【0070】つまり、基体18は、最下層である基板層18Aと中間層であるスペーサ層18Bと最上層である薄板層18Cの積層体であって、スペーサ層18Bのうち、画素に対応する箇所に空所20が形成された一体構造体として把握することができる。基板層18Aは、補強用の基板として機能するほか、配線用の基板としても機能するようになっている。なお、上記基体18は、一体焼成であっても、後付けであってもよい。

【0071】各アクチュエータ部14は、図示するよう40に、上記振動部22と固定部24のほか、該振動部22上に直接形成された圧電／電歪層26と、該圧電／電歪層26の上面に形成された一対の電極28（一方の電極28a及び他方の電極28b）とを有するアクチュエータ部本体30と、図1に示すように、該アクチュエータ部本体30上に接続され、かつ光導波板12との接触面積を大きくして画素に応じた面積にする変位伝達部32とを有して構成されている。

【0072】即ち、本実施の形態に係る表示装置は、基体18上に、圧電／電歪層26及び一対の電極28からなるアクチュエータ部本体30を形成した構造を有す

る。一対の電極28は、圧電／電歪層26に対して上下に形成した構造や片側だけに形成した構造でもかまわないが、基体18と圧電／電歪層26との接合性を有利にするには、本実施の形態に係る表示装置のように、基体18と圧電／電歪層26とが段差のない状態で直接接するように、圧電／電歪層26の上部（基体18とは反対側）のみに一対の電極28を形成した方が好ましい。

【0073】ここで、各部材の形状について図2～図9を参照しながら説明する。まず、図2に示すように、基体18（図1参照）に形成される空所20の周面形状、即ち振動部22の平面形状は円形状とされ（破線参照）、圧電／電歪層26の平面形状（一点鎖線参照）並びに一対の電極28にて形づくられる外周形状（実線参照）も円形状とされている。この場合、振動部22の大きさが最も大きく、次いで一対の電極28の外周形状とされ、圧電／電歪層26の平面形状が最も小さく設定されている。なお、一対の電極28a及び28bの外周形状が最も大きくなるように設定してもよい。

【0074】圧電／電歪層26上に形成される一対の電極28（一方の電極28a及び他方の電極28b）の平面形状は、例えば図3に示すように、これら一対の電極28a及び28bが互いに並行し、かつ相互に離間された数ターンの渦巻き状とされている。この渦巻きのターン数は、実際は、5ターン以上であるが、図3の例では、図面の複雑化を避けるために3ターンとして記載してある。

【0075】そして、各電極28a及び28bに通じる配線は、図2に示すように、多数の画素の行数に応じた本数の垂直選択線40と、多数の画素の列数に応じた本数の信号線42とを有する。各垂直選択線40は、各画素（アクチュエータ部14：図1参照）における一方の電極28aに電気的に接続され、各信号線42は、各画素14の他方の電極28bに電気的に接続されている。また、上記各垂直選択線40は、前列の画素に関する一方の電極28aから導出されて当該画素14に関する一方の電極28aに接続されて、一つの行に関し、シリーズに配線された形となっている。信号線42は、列方向に延びる本線42aと該本線42aから分岐して各画素14の他方の電極28bに接続される支線42bからなる。

【0076】各垂直選択線40への電圧信号の供給は、図示しない配線基板（基体18の他主面に貼り合わされている）からスルーホール44を通じて行われ、各信号線42への電圧信号の供給も、図示しない上記配線基板からスルーホール46を通じて行われるようになっている。

【0077】スルーホール44及び46の配置パターンとしては種々のものが考えられるが、図2の例では、垂直選択線40のスルーホール44は、行数をM、列数をNとしたとき、N=M又はN>Mの場合においては、n

行n列（n=1, 2, ..., M）の画素の近傍で、かつ（n-1）列の信号線（本線42a）寄りの位置に形成され、N<Mの場合においては、（αN+n）行n列（α=0, 1, ..., (M-N商-1)）の画素の近傍で、かつ（n-1）列の信号線（本線42a）寄りの位置に形成される。

【0078】一方、信号線42のスルーホール46は、N=M又はN>Mの場合においては、各信号線42の本線42a上であって、かつn行n列（n=1, 2, ..., N）の画素に近接する位置に形成され、N>Mの場合においては、各信号線42の本線42a上であって、かつn行（βM+n）列（β=0, 1, ..., (N-M商-1)）の画素に近接する位置に形成される。また、垂直選択線40のスルーホール44は、信号線42の場合と異なって、垂直選択線40上に形成されないため、スルーホール44と一方の電極28a間にそれらの電気的導通を図るために中継導体48が形成される。

【0079】なお、各垂直選択線40と各信号線42とが交差する部分には、互いの配線40及び42間の絶縁をとるためにシリコン酸化膜、ガラス膜、樹脂膜等からなる絶縁膜50（二点鎖線で示す）が介在されている。

【0080】上記一対の電極28の平面形状としては、図3に示す渦巻き形状のほかに、図4に示すような形状としてもよい（第1の変形例に係る表示装置）。具体的には、この第1の変形例に係る表示装置は、一対の電極28a及び28bが共に、上記圧電／電歪層26上の中間に向かって延びる幹部52及び54と該幹部52及び54から多数枝分かれしてなる枝部56及び58を有する形状を具備し、かつ一対の電極28a及び28bが、相互に離間されて相補形に配列された形状（以下、便宜的に多枝形状と記す）とされている。

【0081】上記実施の形態に係る表示装置及びその第1の変形例に係る表示装置では、振動部22の平面形状、圧電／電歪層26の平面形状及び一対の電極28にて形づくられる外周形状を円形状とした場合を示したが、その他、図5及び図6に示すように長円形状（トラック形状：第2及び第3の変形例に係る表示装置）や、図7に示すように橢円形状としてもよい（第4の変形例に係る表示装置）。

【0082】また、図8に示すように、振動部22の平面形状及び圧電／電歪層26の平面形状と共に矩形状とし、コーナー部が角のとれた形状や（第5の変形例に係る表示装置）、図9に示すように、振動部22の平面形状及び圧電／電歪層26の平面形状と共に多角形状（例えば八角形状）とし、各頂角部分が丸みを帯びた形状（第6の変形例に係る表示装置）としてもよい。

【0083】また、振動部22の形状、圧電／電歪層26の平面形状、一対の電極28にて形づくられる外周形状は、円と橢円の組み合わせでもよいし、矩形状と橢円の組み合わせでもよく、特に限定されるものではない。

また、圧電／電歪層26の平面形状は、図10及び図11に示すように、リング状とすることも好ましく採用される。この場合も、図13A～13Cに示すように、外周形状として、円、楕円、矩形状など種々のものが挙げられる。図12に圧電／電歪層26の平面形状を円環状とし、一対の電極28a及び28bを多枝形状とした例を示す。

【0084】図2、図8及び図9の例では、基体18上での各アクチュエータ部14(画素)の配置をマトリクス状とした例を示したが、その他、図7で示す第4の変形例に係る表示装置のように、各行に対して画素(アクチュエータ部14)を千鳥状に配置するようにしてもよい。この図7の配置パターンの場合は、各行に関するアクチュエータ部14(画素)の配置が千鳥状となることから、各行に関し、それぞれ垂直選択線40を結ぶライン(一点鎖線aで示す)はジグザグ状とされる。信号線42は、図示しない配線基板において、破線bに示すように、上記千鳥状に配される画素14のうち、例えば垂直方向上側に位置する画素(アクチュエータ部14)に対応する箇所に2本の信号線42を互いに近接させて配線したパターンを有する。そして、図7上、千鳥状に配される画素のうち、例えば垂直方向上側に位置する画素(アクチュエータ部14)の他方の電極28bが、上記互いに近接する2本の信号線42及び44のうち、右側の信号線42と中継導体60及びスルーホール62を通じて電気的に接続され、垂直方向下側に位置する画素(アクチュエータ部14)の他方の電極28bが、上記互いに近接する2本の信号線42及び44のうち、左側の信号線42と中継導体64及びスルーホール66を通じて電気的に接続される。

【0085】次に、上記実施の形態に係る表示装置の動作について図1、図14～図26を参照しながら説明するが、最初に、各アクチュエータ部14での2つの動作例を説明し、次いで、表示装置自体の動作を説明する。

【0086】まず、アクチュエータ部14の第1の動作例について図1、図14及び図15を参照しながら説明する。図1に示す本実施の形態に係る表示装置の各画素(アクチュエータ部14)において、アクチュエータ部14の一方の電極28a及び他方の電極28bに電圧信号が印加されていない場合、即ち、電圧無負荷状態では、一対の電極28a及び28b間に電圧(電位差)は生じないため、圧電／電歪層26に伸びは生じず、変位伝達部32と光導波板12とは離隔された状態にある。

【0087】次に、図14に示すように、アクチュエータ部14の一方の電極28aに例えば正の電圧信号が印加され、他方の電極28bに負の電圧信号が印加されて、一対の電極28a及び28b間が所定電圧となった場合、即ち、電圧印加状態では、圧電／電歪層26の一主面において面方向に電界E(電気力線c参照)が生じる。なお、この電界Eの強さは、圧電／電歪層26の一

主面(表面)が最も大きく、深さ方向に徐々に小さくなる。

【0088】上記電圧印加状態であって、かつ一対の電極28a及び28b間にON選択とすべき電圧が印加されると、前記圧電／電歪層26は、その一主面の面方向に発生した電界Eに応じて伸びを生じるが、圧電／電歪層26をその他主面において支持する振動部22には伸びは生じないため、圧電／電歪層26の一主面と他主面とで歪みに違いが生じ、その結果、図1に示すように、圧電／電歪層26は一主面側を凸とした弾性変形が生じる。この圧電／電歪層26の凸状の弾性変形によって変位伝達部32が光導波板12側に屈曲変位し、該変位伝達部32は光導波板12に接触することとなる。

【0089】上記変位伝達部32は、アクチュエータ部本体30の屈曲変位に対応して光導波板12の背面に接触するものであるが、変位伝達部32が光導波板12の背面に接触すると、例えば光導波板12内で全反射されていた光10が、光導波板12の背面を透過して変位伝達部32の表面まで透過し、変位伝達部32の表面で反射する。

【0090】このように、変位伝達部32は、光導波板12の背面を透過した光10を反射するため、更には光導波板12との接觸面積を所定以上に大きくするために設けられるものである。即ち、変位伝達部32と光導波板12との接觸面積により、発光面積が規定される。

【0091】そして、本実施の形態に係る表示装置では、上記変位伝達部32は、実質的な発光面積を規定する板部材32aとアクチュエータ部本体30の変位を板部材32aに伝達するための変位伝達部材32bを有する。

【0092】なお、変位伝達部32と光導波板12との接觸とは、変位伝達部32と光導波板12とが光10(光導波板12に導入される光10)の波長以下の距離に位置することを意味する。

【0093】一方の電極28a及び他方の電極28bへの電圧信号の供給を停止して、例えばOFF選択あるいは非選択とした場合、一対の電極28a及び28b間に所定電圧は生じなくなるため、圧電／電歪層26は上記凸の状態から元の状態に復元し、変位伝達部32と光導波板12とは離隔された状態となる。

【0094】上記アクチュエータ部14の動作時において、アクチュエータ部本体30の一対の電極28a及び28b間に、前記圧電／電歪層26の分極方向を反転させる信号を印加することにより、自発歪みを除去して上記アクチュエータ部14を駆動するようにしてもよい。

【0095】具体的には、ON選択の場合は、アクチュエータ部本体30の一対の電極28a及び28b間に電圧信号を与えるごとに、圧電／電歪層26の分極方向を反転させる信号、例えば図15に示すように、+100V→-100V→+100V→-100Vの交番信号を

印加して、アクチュエータ部14を駆動する。この場合、アクチュエータ部14での変位量を常に高く維持することができる。これは、圧電／電歪層26の自発歪み分の変位量を常に付加したかたちで変位が得られるためである。なお、OFF選択あるいは非選択の場合は、電界の絶対値が小さい値、例えば絶対値が20V以下である電圧を交番的にかければよい。前記変位量の増大効果は、圧電／電歪層26の平面形状をリング状とした場合(図10～図13参照)においても、前記とほぼ同様に実現することができる。特に、圧電／電歪層26をリング状とすることにより、静電容量を更に小さくできるため、駆動信号のなまり等を有効に抑制できるという効果を得ることができる。

【0096】因みに、圧電／電歪層26を上部電極及び下部電極にて挟んだ構造、即ち、従来のサンドイッチ構造では、上記駆動を行っても変位量は大きくならない。

【0097】次に、アクチュエータ部の第2の動作例について図1、図16～図25を参照しながら説明するが、その前に、第2の動作例に基づくアクチュエータ部14の動作原理について図1、図16～図19を参照しながら説明する。

【0098】まず、本実施の形態に係る表示装置は、図16Bに示すように、前記一对の電極28a及び28b間の印加電界による前記アクチュエータ部14の屈曲変位特性が基準電界点(電界E=0の点)を中心に非対称となる。

【0099】この屈曲変位特性は、アクチュエータ部本体30における一对の電極28a及び28b間に所定電圧を印加し、圧電／電歪層26を分極処理した後、アクチュエータ部14に加えられる電圧を連続的に変化させたときのアクチュエータ部14の屈曲変位をしたものである。この場合の屈曲変位とは、図1に示すように、アクチュエータ部14が一方向(圧電／電歪層26上に形成された一对の電極28a及び28bが自由空間を臨む方向)に対して凸状に屈曲変位する場合を正方向、凹状に屈曲変位する場合を負方向としている。

【0100】具体的に前記屈曲変位特性の測定について一例をあげて説明する。まず、図17Aに示すように、例えば圧電／電歪層26を分極処理するために一对の電極28a及び28b間に例えば正方向に所定電圧をかけると、圧電／電歪層26の一主面において面方向に正方向の電界(例えば図16Bにおいて+5Eで示す電界)が生じる。ここで、1E=約2.5kV/mmである。

【0101】圧電／電歪層26に発生する電界の強さは、前記一主面が最も大きく、深さ方向に徐々に小さくなる。そのため、深い部分の分極は進行しにくいが、十分な電界、十分な時間、適度な熱を加えて分極を深さ方向まで進めることができる。

【0102】表示装置のアクチュエータ部14として使用する電界の使用範囲(例えば図16Bにおいて+3E

～-3Eの範囲)を超えた電界(+5E)を例えば7時間、適度な温度下において印加することによって、加えられた電界と同じ方向に分極処理される。

【0103】その後、図17Bに示すように、一对の電極28a及び28b間への電圧印加を停止して電圧無負荷状態とする。そして、測定開始と共に、アクチュエータ部14に周波数1Hz、ピーク値±3Eの正弦波(図16A参照)を印加し、そのときの各ポイント(点A～点D)での変位量を連続してレーザ変位計で測定する。そのときの測定結果を電界-屈曲変位グラフにプロットしたものが図16Bの特性図である。図16Bの矢印に示されるように、屈曲変位の変位量は、電界の連続的な増減によってある程度のヒステリシスをもって連続的に変化している。

【0104】具体的に、測定を点Aで示す電界+3Eの時点から開始したとすると、まず、点Aにおいては、図18Aに示すように、圧電／電歪層26における分極方向と電界の方向とが一致し、圧電／電歪層26の表面近くでは電界が強くかかることから、圧電／電歪層26は水平方向に伸びることとなり、アクチュエータ部14は、一方向(圧電／電歪層26上に形成された一对の電極28a及び28bが自由空間を臨む方向)に約0.8△yほど屈曲変位する(図16B参照)。なお、1△y=約1.6μmである。

【0105】その後、一对の電極28a及び28b間に印加される電圧が変化して、アクチュエータ部14に分極処理時の電界の方向と逆の方向の電界が発生している段階では、以下のようないくつかの動作を行うことになる。

【0106】まず、電界が弱い例えば点B(-0.6E)の段階では、図18Bに示すように、圧電／電歪層26の分極の方向と電界の方向が互いに逆になっており、圧電／電歪層26は、水平方向に縮むこととなる。これによって、アクチュエータ部14は、他方向(圧電／電歪層26から振動部22に向かう方向)に約-0.3△yほど屈曲変位する。また、この段階は、圧電／電歪層26の表面部分における分極が反転はじめる段階であり、従って、この点Bでの電界(-0.6E)を所定電界と定義することができる。

【0107】その後、負方向の電界が強くなってくると、図19Aに示すように、圧電／電歪層26の表面部分における分極反転が進行し、圧電／電歪層26の表面付近では分極の方向と電界の方向が一致し、圧電／電歪層26の深い部分では分極の方向と電界の方向が逆になるという現象が生じる。即ち、圧電／電歪層26において、2種類の分極が存在することとなり、擬似的なバイモルフ型のアクチュエータ部14として機能することになる。特に、電界が-3Eとなった段階においては、アクチュエータ部14の変位量は、前記擬似的なバイモルフ的性質によって非常に大きいものとなり、図16Bの例では、変位=約2.6△yとなっている。

【0108】次に、電界が負方向から正方向に移り、電界が弱い例えは点D (+0.6E) の段階では、図19Bに示すように、圧電/電歪層26の表面付近では分極の方向と電界の方向が逆であり、圧電/電歪層26の深い部分では分極の方向と電界の方向が一致しており、圧電/電歪層26は、その表面付近が水平方向に縮み、深い部分が水平方向に伸びるかたちとなる。これによって、アクチュエータ部14は、他方向(圧電/電歪層26から振動部22に向かう方向)に約-1.0Δyほど屈曲変位する。また、この段階は、圧電/電歪層26の表面部分における分極が反転はじめる段階であり、従って、この点Dでの電界(+0.6E)を点Bと同様に所定電界と定義することができる。

【0109】そして、正方向への電界が徐々に強くなるに従って、圧電/電歪層26における表面付近の分極反転が進行し、圧電/電歪層26の分極の方向と電界の方向が一致することとなる。従って、点Dから点Aに向かう段階は、再分極処理段階と呼ぶこともできる。

【0110】以上のように、前記屈曲変位特性が対称性を有するか非対称性を有するかを評価するには、所定電界(±0.6E)より十分に大きい電界で測定する必要がある。しかし、所定電界より僅かに大きい電界で測定すると、本実施の形態に係る表示装置のアクチュエータ部14の特有の特性である非対称性が判別できない場合が生ずる。

【0111】そこで、屈曲変位特性の非対称性を判別するには、部分的に分極の方向が反転はじめる電界(ここでは所定電界と定義している)の4倍以上の電界を交番的につけて屈曲変位特性を評価することが望ましい。つまり、絶対変位量を大きくして測定すれば屈曲変位特性の非対称性を容易に評価することができる。

【0112】例えは、従来例に係る表示装置においては、所定電界が±0.5Eであるから、正方向の電界を+2.0E以上とし、負方向の電界を-2.0E以下にして測定を行えばよい。また、本実施の形態に係る表示装置においては、前記所定電界が±0.6Eであるから、正方向の電界を+2.4E以上とし、負方向の電界を-2.4E以下にして測定を行えばよい。

【0113】図16Bでは、所定電界(±0.6E)よりも十分に大きい電界(±3E)を交番的につけて屈曲変位特性を測定しており、この場合、正方向の電界のピーク値(点A)における変位量y_aが0.8Δy、負方向の電界のピーク値(点C)における変位量y_cが2.6Δyであり、y_c=3.25y_aの関係になっている。

【0114】次に、前記屈曲変位特性に非対称性をもたらせるための寸法関係について説明する。まず、前記一对の電極28a及び28b間の距離xと圧電/電歪層26の厚みyをみたとき、図20に示すように、1μm≤x≤200μm、1μm≤y≤100μmとし、かつ、y

=axの関係を有するようにして、1/10≤a≤10の範囲を満たすようにする。特に比例定数aについては、好ましくは1/5≤a≤10であり、更に好ましくは、1/2≤a≤5である。この場合、1μm≤x≤60μm、1μm≤y≤40μmを満たせば、分極方向と逆方向の電界印加の際に、圧電/電歪層26が適當な深さまで容易にその分極方向が反転し、変位量を効果的に高められるため、アクチュエータ部14として最適となる。

10 【0115】ここで、一对の電極28a及び28b間の距離xは、該一对の電極28a及び28bの平面形状が渦巻き状である場合は、図21Aに示すように、例えは一方の電極28aにおける外方側周縁から1本の法線R1を引いたとき、該法線R1の起点Q1と該法線R1と他方の電極28bにおける内方側周縁との交点Q2との間の距離を指す。

【0116】また、一对の電極28a及び28bの平面形状が多枝形状である場合は、図21Bに示すように、例えは一方の電極28aの枝部56における外方側周縁から1本の法線R2を引いたとき、該法線R2の起点Q3と該法線R2と他方の電極28bの枝部58における内方側周縁との交点Q4との間の距離を指す。

【0117】次に、圧電/電歪層26の厚みyと振動部22の厚みzをみた場合は、図22に示すように、1μm≤y≤100μm、1μm≤z≤50μmとし、かつ、y=bzの関係を有するようにして、1/5≤b≤10の範囲を満たすようにする。特に比例定数bについては、好ましくは1/3≤b≤5である。この場合、1μm≤y≤40μm、1μm≤z≤20μmを満たせば、分極方向と逆方向の電界印加の際に、圧電/電歪層26が適當な深さまで容易にその分極方向が反転し、変位量を効果的に高められるため、アクチュエータ部14として最適となる。

【0118】更に、本実施の形態に係る表示装置においては、第1の動作例及び第2の動作例に拘わらず、図23及び図24に示すように、前記振動部22の中心を通る最短寸法mにおける断面形状が、以下の条件を満足することが好ましい。なお、図23及び図24においては、図面の複雑化を避けるために一对の電極28a及び28bの記載を省略してある。

【0119】即ち、図23Bに示すように、前記固定部24に近接する一方の最外極小点P1と他方の最外極小点P2とを結ぶことによって構成される基準線Lにより、前記圧電/電歪層26の中央部付近における上面の少なくとも一部分が、電圧無負荷状態(電界E=0の状態)で前記振動部22と反対方向に突出していることである。

【0120】ここで、圧電/電歪層26の中央部付近とは、図23Aに示すように、前記最短寸法mにおいて、固定部24の上面と振動部22の上面との境界部分をそ

それぞれ一方の境界点K 1 及び他方の境界点K 2 と定義し、前記最短寸法を100としたとき、前記一方の境界点K 1 から最短寸法mの中心に向かって30%の範囲a 1と、前記他方の境界点K 2 から最短寸法mの中心に向かって30%の範囲a 2 を除く、中央の40%の範囲a 3を指す。

【0121】また、図23Bに示すように、前記一方の最外極小点P 1とは、前記最短寸法mにおいて、前記圧電／電歪層2 6の一主面及び振動部2 2の上面の前記最短寸法面に対する投影線に形成される複数の極小点のうち、前記一方の境界点K 1に最も近接する極小点をいい、他方の最外極小点P 2とは前記複数の極小点のうち、前記他方の境界点K 2に最も近接する極小点をいう。

【0122】この場合、前記最短寸法を100としたとき、前記一方の境界点K 1から最短寸法mの中心に向かって40%の範囲（一方の極小点存在領域b 1）内に存在するもので、かつ一方の境界点K 1に最も近接する極小点が一方の最外極小点P 1として認定され、前記他方の境界点K 2から最短寸法mの中心に向かって40%の範囲（他方の極小点存在領域b 2）内に存在するもので、かつ他方の境界点K 2に最も近接する極小点が他方の最外極小点P 2として認定される。

【0123】前記最外極小点P 1及びP 2は、図23Bに示すように、固定部2 4の上面よりも下方に存在する場合や、図18Cに示すように、固定部2 4の上面よりも上方に存在する場合がある。

【0124】なお、図24Aに示すように、例えば他方の極小点存在領域b 2内に他方の最外極小点P 2が存在しない場合は、前記他方の境界点K 2が他方の最外極小点P 2として認定される。これは、一方の最外極小点P 1でも同じである。また、図23A及び図24Bに示すように、両方の極小点存在領域b 1及びb 2内にそれぞれ最外極小点P 1及びP 2が存在しない場合は、一方の境界点K 1及び他方の境界点K 2がそれぞれ一方の最外極小点P 1及び他方の最外極小点P 2として認定される。

【0125】そして、前記条件、つまり、「基準線より圧電／電歪層2 6の中央部付近における上面の少なくとも一部分が、電圧無負荷状態で振動部2 2と反対方向に突出すること。」という条件において、前記最短寸法長をmとしたとき、その突出量tがm/1000≤t≤m/10を満たすことがより好ましい。

【0126】前記条件を満たすことにより、作製されたアクチュエータ部1 4に対して必ず一方向に大きな変位を行わせることができ、表示装置に使用した場合の歩留まりの向上を達成させることができる。

【0127】次に、アクチュエータ部1 4での第2の動作例について説明する。まず、図1に示す本実施の形態に係る表示装置について、その駆動とは別に各画素（ア

クチュエータ部1 4）に対して分極処理（初期分極処理）を行う。この初期分極処理は、アクチュエータとして使用する電界の使用範囲（例えば図16Bにおいて+3E～-3Eの範囲）を超えた電界(+5E)を例えれば7時間、適度な温度下において印加することにより行われる。これによって、各画素における圧電／電歪層2 6は、加えられた電界と同じ方向に分極処理される。

【0128】全ての画素について、初期分極処理が終了した段階で、一対の電極2 8a及び2 8b間への電圧印加を停止して電圧無負荷状態とする。

【0129】そして、表示装置に対する駆動においては、画素に対して基本的に3つの動作(ON選択、OFF選択及び非選択)を行わせることによって画像を表示するようになっている。

【0130】ON選択は、図25Aに示すように、所定の選択期間T sにおいて、画素の一対の電極2 8a及び2 8bに電圧V aを印加することにより、一対の電極2 8a及び2 8b間に負方向の電界E a(図16B参照)を発生させることにより行われる。OFF選択は、図25Bに示すように、所定の選択期間T sにおいて、画素の一対の電極2 8a及び2 8bに電圧V dを印加することにより、一対の電極2 8a及び2 8b間に負方向又は正方向の電界E d(図16B参照)を発生させることにより行われる。

【0131】非選択は、図25A又は図25Bに示すように、選択期間T s以外の期間(非選択期間T a)において、画素の一対の電極2 8a及び2 8bに電圧V f又はV gを印加することにより、一対の電極2 8a及び2 8b間に正方向の電界E f又はE g(図16B参照)を発生させることにより行われる。この非選択期間T aにおいては、初期分極処理と同様に正方向の電界が発生することから、非選択状態とされた画素の圧電／電歪層2 6は分極処理に準じた処理(便宜的に再分極処理と記す)が行われる。

【0132】本実施の形態に係る表示装置の駆動動作について具体的に説明すると、表示装置への画像信号の入力に基づいて、例えばシフトレジスタにて構成された垂直シフト回路による垂直選択線4 0への電位供給に従って、1水平走査期間毎に、例えば1行目、2行目、…n行目というように1行ずつ画素群が選択されていくが、選択された行のうち、ON選択すべき画素1 4に関する信号線4 2に対して、例えばシフトレジスタにて構成された水平シフト回路から所定の選択期間T sにわたって電位供給が行われる。その結果、垂直シフト回路と水平シフト回路によってON選択された画素1 4は、その一方の電極2 8aに負の所定電位が印加され、他方の電極2 8bに正の電位が印加されて、一対の電極2 8a及び2 8b間の電圧が負方向の所定電圧V a(図25A参照)とされる。このとき、図16B及び図19Aに示すように、例えば一対の電極2 8a及び2 8b間には負

方向の電界E a（例えば-3 E：初期分極処理や非選択時の電界とは逆方向の電界）が発生し、当該画素におけるアクチュエータ部14は、約 $2.6 \Delta y$ ほど一方向に変位する。この状態は表示装置でみた場合、ON選択状態を示す。このON選択状態では、アクチュエータ部14の凸状変形によって変位伝達部32が光導波板12側に変位し、該変位伝達部32は光導波板12に接触することとなる。

【0133】一方、垂直シフト回路にて選択された行に関する画素群のうち、ON選択しない画素又はOFF選択した画素14については、所定の選択期間T_sにわたって当該画素14に関する信号線42の電位がON選択時の電位とは異なる電位とされ、当該画素14の一方の電極28aに負の所定電位が印加され、他方の電極28bに負又は正の電位が印加されて、一対の電極28a及び28b間の電圧が負方向又は正方向の所定電圧Vd（図25B参照）どされる。このとき、図16Bに示すように、例えば一対の電極28a及び28b間には負方向又は正方向の電界E d（例えば-0.6E～+0.6E）が発生し、当該画素におけるアクチュエータ部14は、約 $-1.0 \Delta y$ ～ $0.5 \Delta y$ ほど一方向に変位する。この状態は、表示装置でみた場合、OFF選択状態を示す。このOFF選択状態では、アクチュエータ部14の前記変位動作によって変位伝達部32が光導波板12側から離間した状態となる。

【0134】ON選択あるいはOFF選択された画素に関するアクチュエータ部14は、その後の非選択状態において、再分極処理され、一方向（圧電／電歪層26上に形成された一対の電極28a及び28bが自由空間を臨む方向）に約 $1 \Delta y$ ほど変位することとなる。この非選択状態では、他の行におけるON選択やOFF選択に基づく電圧変化が重畠してある電圧レベルVgやVf（図25A及び図25B参照）となるが、この重畠成分（クロストーク成分）の存在が非選択状態のアクチュエータ部14に対してある程度の再分極処理を行わせることから、電界の変化に対する変位量の回復や表示装置としての応答性の回復に役立つことになる。つまり、前記クロストーク成分が応答性の回復を兼用することになる。

【0135】なお、ON選択を行うための電圧レベルとしては、電圧レベルVb（図16Bにおいて電界Eb（例えば-2E）に相当する電圧レベル）よりも負方向の電圧レベルであればよく、OFF選択を行うための電圧レベルとしては、電圧レベルVc～Veの範囲（図16Bにおいて電界Ec（例えば-0.6E）～Ee（+0.6E）の範囲に相当する電圧レベル）内のいずれかの電圧レベルであればよい。また、再分極処理を行うための電圧レベルとしては、電圧レベルVe（図16Bにおいて電界Ee（例えば+0.6E）に相当する電圧レベル）よりも正方向の電圧レベルであればよい。

【0136】次に、本実施の形態に係る表示装置の動作を図1を参照しながら説明する。まず、光導波板12の例え端部から光10が導入される。この場合、光導波板12の屈折率の大きさを調節することにより、全ての光10が光導波板12の前面及び背面において透過することなく内部で全反射する。この状態において、あるアクチュエータ部14が電圧印加状態あるいはON選択状態とされて、光導波板12の背面に前記アクチュエータ部14に対応する変位伝達部32が光の波長以下の距離で接触すると、それまで全反射していた光10は、光導波板12の背面に接觸している変位伝達部32の表面まで透過する。一旦、変位伝達部32の表面に到達した光10は、変位伝達部32の表面で反射して散乱光70として、一部は再度光導波板12の中で反射するが、散乱光70の大部分は光導波板12で反射されることなく、光導波板12の前面を透過することになる。

【0137】つまり、光導波板12の背面にある変位伝達部32の接觸の有無により、光導波板12の前面における光の発光（漏れ光）の有無を制御することができる。特に、本実施の形態に係る表示装置では、光導波板12に対して変位伝達部32を接觸・離隔方向に変位動作させる1つの単位を1画素とし、更にこの画素を多数マトリクス状、あるいは各行に関し千鳥状に配列するようしているため、入力される画像信号の属性に応じて各画素での変位動作を制御することにより、陰極線管や液晶表示装置と同様に、光導波板12の前面に画像信号に応じた映像（文字や図形等）を表示させることができる。

【0138】次に、本実施の形態に係る表示装置をカラー表示方式に適用する場合について説明する。まず、本実施の形態に係る表示装置の発色の原理は、現行のカラー表示方式と同様に、色の三原色であるR（赤）、G（緑）、B（青）の混合方式で規定される。ここで、発色させる周期をTとして、RGBの最大発光時間を3分割することを考えた場合、図26Aに示すように、RGBの発光時間の比率が1：1：1であれば、白色光となり、図26Bに示すように、RGBの発光時間の比率が4：1：5であれば、その比率に応じた中間色になる。従って、発色させる時間の制御は、光導波板12と変位伝達部32との接觸時間を発色させる周期Tに同期させて、三原色の発光時間を制御してもよいし、三原色の発光時間を発色させる周期Tに同期させて、光導波板12と変位伝達部32との接觸時間を制御することもできる。

【0139】このようなことから、本実施の形態に係る表示装置においては、カラー表示方式に適用させる場合であっても、画素数を白黒画面の場合に比して増加させる必要がないという利点がある。

【0140】なお、前記本実施の形態では、各画素に対しての再分極処理を非選択期間に行うようにしている

が、その他、Rの発光終了時点から次のGの発光開始時点までの期間、Gの発光終了時点から次のBの発光開始時点までの期間、Bの発光終了時点から次のRの発光開始時点までの期間の3つの期間において、例えば初期分極処理と同じ電界を印加して再分極処理するようにしてもよい。この場合、前記非選択期間における再分極処理と組み合わせるようにしてよい。

【0141】光導波板12に入射させる照明光の光源としては、例えば、蛍光管、発光ダイオード、レーザ光等が好ましく使われる。また、ハロゲンランプやキセノンランプとカラーフィルタを組み合わせて使用してもよい。RGBの切り替えは、機械的シャッタやスイッチのON/OFFを利用することにより実現できる。

【0142】本実施の形態に係る表示装置は、単一で使用できるほか、図27に示すように、本実施の形態に係る表示装置を大画面表示装置72の1つの表示素子74としても可能である。この図27の例では、大画面の表示面積を有する導光板76の背面に、表示素子74を縦方向に7個、横方向に18個配列させた例を示す。この場合、導光板76は、ガラス板やアクリル板等の可視光領域での光透過率が大であって均一なものが使用され、各表示素子74間は、ワイヤボンディングや半田付け、端面コネクタ、裏面コネクタ等で接続することにより相互間の信号供給が行えるようになっている。

【0143】また、図27に示す大画面表示装置72においては、各表示素子74に適用される表示装置として例えば図7に示す表示装置を使用し、その画素の並びを水平方向に32個、垂直方向に32個としたものを用いている。図7に示す表示装置は、各行に関する画素の並びを千鳥状としているため、画素の水平方向の配列ピッチを非常に小さくすることができ、水平方向及び垂直方向の画素の配列数を同一にした場合、全体的な平面形状は、縦長形状となる。

【0144】図27に示す大画面表示装置72においては、大型の導光板76の板面に、光導波板12を含む表示素子74をマトリクス状に配置した例を示したが、その他、大型の導光板76を省略して、光導波板12を含む表示素子74をマトリクス状に配置したもので大画面表示装置72を構成するようにしてもよい。この場合、マトリクス状に配された多数の光導波板12が前記大型の導光板76を兼用することになる。前記構成のほか、大型の導光板76の板面に、光導波板12を含まない表示素子74をマトリクス状に配置して前記大画面表示装置72を構成するようにしてもよい。

【0145】前記導光板76と光導波板12は屈折率が類似したものが好ましく、導光板76と光導波板12とを貼り合わせる場合には、透明な接着剤を用いてよい。この接着剤は、光導波板12や導光板76と同様に、可視光領域で均一で、高い透過率を有することが好ましく、また、屈折率も導光板76や光導波板12と近

いものに設定することが画面の明るさを確保する上で望ましい。

【0146】次に、上記アクチュエータ部14の各構成部材、特に各構成部材の材料等の選定について説明する。

【0147】まず、振動部22は、高耐熱性材料であることが好ましい。その理由は、アクチュエータ部14を有機接着剤等の耐熱性に劣る材料を用いずに、固定部24によって直接振動部22を支持させる構造とする場合、少なくとも圧電/電歪層26の形成時に、振動部22が変質しないようにするために、振動部22は、高耐熱性材料であることが好ましい。

【0148】また、振動部22は、基体18上に形成される一対の電極28における一方の電極28aに通じる垂直選択線40と他方の電極28bに通じる信号線42との電気的な分離を行うために、電気絶縁材料であることが好ましい。

【0149】従って、振動部22は、高耐熱性の金属あるいはその金属表面をガラス等のセラミックス材料で被覆したホーロー等の材料であってもよいが、セラミックスが最適である。

【0150】振動部22を構成するセラミックスとしては、例えば安定化された酸化ジルコニア、酸化アルミニウム、酸化マグネシウム、酸化チタン、スピネル、ムライト、窒化アルミニウム、窒化珪素、ガラス、これらの混合物等を用いることができる。安定化された酸化ジルコニアは、振動部22の厚みが薄くても機械的強度が高いこと、韌性が高いこと、圧電/電歪層26及び一対の電極28との化学反応性が小さいこと等のため、特に好ましい。安定化された酸化ジルコニアとは、安定化酸化ジルコニア及び部分安定化酸化ジルコニアを包含する。安定化された酸化ジルコニアでは、立方晶等の結晶構造をとるため、相転移を起こさない。

【0151】一方、酸化ジルコニアは、1000°C前後で、单斜晶と正方晶とで相転移し、この相転移のときにクラックが発生する場合がある。安定化された酸化ジルコニアは、酸化カルシウム、酸化マグネシウム、酸化イットリウム、酸化スカンジウム、酸化イッテルビウム、酸化セリウム又は希土類金属の酸化物等の安定化剤を、1~30モル%含有する。振動部22の機械的強度を高めるために、安定化剤が酸化イットリウムを含有することが好ましい。このとき、酸化イットリウムは、好ましくは1.5~6モル%含有し、更に好ましくは2~4モル%含有することであり、更に0.1~5モル%の酸化アルミニウムが含有されていることが好ましい。

【0152】また、結晶相は、立方晶+单斜晶の混合相、正方晶+单斜晶の混合相、立方晶+正方晶+单斜晶の混合相などであってもよいが、中でも主たる結晶相が、正方晶、又は正方晶+立方晶の混合相としたものが、強度、韌性、耐久性の観点から最も好ましい。

【0153】振動部22がセラミックスからなるとき、多数の結晶粒が振動部22を構成するが、振動部22の機械的強度を高めるため、結晶粒の平均粒径は、0.05~2μmであることが好ましく、0.1~1μmであることが更に好ましい。

【0154】固定部24は、セラミックスからなることが好ましいが、振動部22の材料と同一のセラミックスでもよいし、異なっていてもよい。固定部24を構成するセラミックスとしては、振動部22の材料と同様に、例えば、安定化された酸化ジルコニウム、酸化アルミニウム、酸化マグネシウム、酸化チタン、スピネル、ムライト、窒化アルミニウム、窒化珪素、ガラス、これらの混合物等を用いることができる。

【0155】特に、本実施の形態に係る表示装置で用いられる基体18は、酸化ジルコニウムを主成分とする材料、酸化アルミニウムを主成分とする材料、又はこれらの混合物を主成分とする材料等が好適に採用される。その中でも、酸化ジルコニウムを主成分としたものが更に好ましい。なお、焼結助剤として粘土等を加えることもあるが、酸化珪素、酸化ホウ素等のガラス化しやすいものが過剰に含まれないように、助剤成分を調節する必要がある。なぜなら、これらガラス化しやすい材料は、基体18と圧電/電歪層26とを接合させる上では有利ではあるものの、基体18と圧電/電歪層26との反応を促進し、所定の圧電/電歪層26の組成を維持することが困難となり、その結果、素子特性を低下させる原因となるからである。

【0156】即ち、基体18中の酸化珪素等は重量比で3%以下、更に好ましくは1%以下となるように制限することが好ましい。ここで、主成分とは、重量比で50%以上の割合で存在する成分をいう。

【0157】圧電/電歪層26の構成材料として、好適には圧電性セラミックスを用いることができるが、電歪セラミックス又は強誘電体セラミックスであってもよく、更には、分極処理が必要な材料であっても、必要な材料であってもよい。更にまた、セラミックスに限定されず、PVDF(ポリフッ化ビニリデン)に代表される高分子からなる圧電体ないしはこれら高分子とセラミックスの複合体であってもよい。

【0158】圧電/電歪層26に用いるセラミックスとしては、例えば、ジルコン酸鉛、マグネシウムニオブ酸鉛、ニッケルニオブ酸鉛、亜鉛ニオブ酸鉛、マンガンニオブ酸鉛、マグネシウムタンタル酸鉛、ニッケルタンタル酸鉛、アンチモンスズ酸鉛、チタン酸鉛、チタン酸バリウム、マグネシウムタンクスチン酸鉛、コバルトニオブ酸鉛等、又はこれらの何れかの組合せを含有するセラミックスが挙げられる。これらの化合物が50重量%以上を占める主成分であってもよいことはいうまでもない。また、上記セラミックスのうち、ジルコン酸鉛を含有するセラミックスは、本実施の形態の圧電/電歪層2

6の構成材料として最も使用頻度が高い。

【0159】また、圧電/電歪層26をセラミックスにて構成する場合、上記セラミックスに、更に、ランタン、カルシウム、ストロンチウム、モリブデン、タンクスチン、バリウム、ニオブ、亜鉛、ニッケル、マンガン等の酸化物、若しくはこれらの何れかの組合せ、又は他の化合物を、適宜、添加したセラミックスを用いてもよい。

【0160】10 例えば、マグネシウムニオブ酸鉛とジルコン酸鉛及びチタン酸鉛とからなる成分を主成分とし、更にランタンやストロンチウムを含有するセラミックスを用いることが好ましい。

【0161】【0161】圧電/電歪層26は、緻密であっても、多孔質であってもよく、多孔質の場合、その気孔率は40%以下であることが好ましい。

【0162】20 そして、上記基体18における振動部22の厚みと該振動部22上に形成される圧電/電歪層26の厚みは、同次元の厚みであることが好ましい。なぜなら、振動部22の厚みが極端に(1桁以上異なる場合)、圧電/電歪層26の厚みより厚くなると、圧電/電歪層26の焼成収縮に対して、振動部22がその収縮を妨げるよう働くため、圧電/電歪層26と基体18界面での応力が大きくなり、はがれ易くなる。反対に、厚みの次元が同程度であれば、圧電/電歪層26の焼成収縮に基体18(振動部22)が追従し易くなるため、一体化には好適である。具体的には、振動部22の厚みは、1~100μmであることが好ましく、3~50μmが更に好ましく、5~20μmが更にお好ましい。一方、圧電/電歪層26は、その厚みとして5~100μmが好ましく、5~50μmが更に好ましく、5~30μmが更にお好ましい。

【0163】30 上記圧電/電歪層26上に形成される一対の電極28は、用途に応じて適宜な厚さとするが、0.01~50μmの厚さであることが好ましく、0.1~5μmが更に好ましい。また、上記一対の電極28は、室温で固体であって、導電性の金属で構成されていることが好ましい。例えば、アルミニウム、チタン、クロム、鉄、コバルト、ニッケル、銅、亜鉛、ニオブ、モリブデン、ルテニウム、ロジウム、銀、スズ、タンタル、タンクスチン、イリジウム、白金、金、鉛等を含有する金属単体又は合金が挙げられる。これらの元素を任意の組合せで含有していてもよいことはいうまでもない。

【0164】40 変位伝達部32の変位伝達部材32bは、アクチュエータ部14の変位を直接光導波板12に伝達できる程度の硬度を有するものが好ましい。従って、上記変位伝達部材32bの材質としては、ゴム、有機樹脂、有機接着フィルム、ガラス等が好ましいものとして挙げられるが、電極層そのものあるいは圧電体ないしは上述したセラミックス等の材質であってもかまわない。50 最も好ましくは、エポキシ系、アクリル系、シリコーン

系、ポリオレフィル系等の有機樹脂又は有機接着フィルムがよい。更に、これらにフィラーを混ぜて硬化収縮を抑制することも有効である。

【0165】板部材32aの材質としては、前記変位伝達部材32bの材料のほか、エポキシ系、アクリル系、シリコーン系等の有機樹脂に高屈折率を有するセラミック粉末、例えばジルコニア粉末、チタニア粉末、酸化鉛粉末、それらの混合粉末等を高分散させた材料が、発光効率、平坦性維持の点で望ましい。この場合、樹脂重量：セラミック粉末重量=1：(0.1~1.0)がよい。更に、前記組成に平均粒径0.5~1.0μmのガラス粉末をセラミック粉末に対して1：(0.1~1.0)の割合で添加すると、光導波板12の面との接触性、離型性が改良されるため好ましい。

【0166】なお、前記板部材32aは、光導波板12と接触する部分（面）の平坦度、平滑度が、アクチュエータ部14の変位量に比較して十分小さくすることが好ましく、具体的には、1μm以下、更に好ましくは0.5μm以下、特に好ましくは0.1μm以下である。但し、変位伝達部32の光導波板12と接触する部分

（面）の平坦度は、変位伝達部32が光導波板12に接触した状態での隙間を減するために重要であって、接触した状態で当該接触部分が変形するものであれば上記平坦度に必ずしも限定されるものではない。

【0167】前記変位伝達部32のアクチュエータ部本体30への接続は、変位伝達部32として上述した材料を使用する場合には、接着剤を使って上述した材料の変位伝達部32を積層するか、上述した材料の溶液、ペーストないしスラリーをコーティングする等の方法によりアクチュエータ部本体30の上部、あるいは光導波板12上、又は導光板76（図27参照）上に形成することにより行えばよい。

【0168】前記変位伝達部32をアクチュエータ部本体30に接続する場合は、好ましくは、変位伝達部材32bの材料を接着剤として兼ねる材料とすればよい。特に、有機接着フィルムを用いれば、熱をかけることで接着剤として使えるため、好ましい。

【0169】光導波板12は、その内部に導入された光10が前面及び背面において光導波板12の外部に透過せずに全反射するような光屈折率を有するものであり、可視光波長領域での透過率が均一で、かつ高いものであることが必要である。このような特性を具備するものであれば、特にその材質は制限されないが、具体的には、例えばガラス、石英、アクリル等の透光性プラスチック、透光性セラミックスなど、あるいは異なる屈折率を有する材料の複数層構造体、又は表面にコーティング層を設けたものなどが一般的なものとして挙げられる。

【0170】次に、本実施の形態に係る表示装置の製造方法を説明する。振動部22及び固定部24を含む基体18は、グリーンシート又はグリーンテープである成形

層を熱圧着等で積層し、次いで焼成することで一体化できる。例えば、図1の基体18では、2層のグリーンシート又はグリーンテープを積層するが、その第2層に空所20となる所定形状の窓部を積層前に予め設けておけばよい。また、成形型を用いる加圧成形、鋳込み成形、射出成形等によって、成形層を作製し、切削、研削加工、レーザ加工、プレス加工による打ち抜き等の機械加工により、空所20となる窓部等を設けててもよい。図1では、2層構造となっているが、3層構造、4層構造として基体18の剛性を向上させたり、裏面配線板として使用する層を同時に積層して形成してもよい。

【0171】次に、上記基体18の振動部22上にアクチュエータ部本体30を形成する。この場合、金型を用いたプレス成形法又はスラリー原料を用いたテープ成形法等によって圧電/電歪層26を成形し、この焼成前の圧電/電歪層26を焼成前の基体18における振動部22上に熱圧着で積層し、同時に焼成して、基体18の振動部22上に圧電/電歪層26を形成する方法と、以下に示す膜形成法がある。

【0172】膜形成法は、振動部22上に圧電/電歪層26及び一对の電極28をこの順序で積層する方法であるが、例えば、スクリーン印刷のような厚膜法、ディップティング等の塗布法、イオンビーム、スパッタリング、真空蒸着、イオンプレーティング、化学蒸着法(CVD)、メッキ等の薄膜法等が適宜用いられる。一对の電極28につながる配線40及び42や端子パッドの形成も上記厚膜法や薄膜法が用いられる。

【0173】本実施の形態に係る表示装置は、その一例として、例えば以下のようないくつかの製法が採用される。まず、基体18の振動部22上にスクリーン印刷法によって圧電/電歪層26を形成する。その後、焼成を行って、基体18の振動部22上に圧電/電歪層26を接合する。この場合、基体18と圧電/電歪層26との接合性を向上させて、これら基体18と圧電/電歪層26との一体化を有利にするには、圧電/電歪層26に対する焼成を圧電/電歪層材料の雰囲気下で密閉容器内で実施することが好ましい。更に好ましくは、雰囲気濃度は高くすることが望ましい。

【0174】雰囲気焼成は次の方法等により行われる。

【0175】(1) 圧電/電歪層材料と同成分系の粉末を蒸発源として一緒に密閉容器内に置く。

【0176】(2) 圧電/電歪層材料の組成として、鉛成分を予め過剰とする。

【0177】(3) 圧電/電歪層材料の板をセッターとして使用する。

【0178】また、焼成温度は、900~1400℃が好ましく、更に好ましくは1100~1400℃が望ましい。

【0179】上記基体18と圧電/電歪層26との接合が終了した後、一对の電極28を含む配線層パターンを

形成する。この形成は、例えば導体粉末や有機金属、又はレジネート等の導体ペーストをスクリーン印刷にて積層することにより行われる。この配線層のパターンは、例えば図2に示すように、垂直選択線40のパターン、信号線42のパターン及び電極パターンであって、電極パターンは、この段階（スクリーン印刷段階）では図3に示すような渦巻き形状や図4に示すような多枝形状ではなく、単に円形状とされた状態である。

【0180】その後、例えばエキシマレーザによって円形状の電極パターンの所要箇所を蒸発させることにより、図3に示すような渦巻き形状や図4に示すような多枝形状にバーニングして一対の電極28a及び28bとする。

【0181】上記エキシマレーザによるバーニングが終了した後、熱処理することにより、基体18上へのアクチュエータ部本体30の形成が終了する。なお、薄膜法により、一対の電極28a及び28bを形成する場合においては、必ずしも上記熱処理は必要としない。

【0182】上記基体18上へのアクチュエータ部本体30の形成が終了した後に、変位伝達部32の接続が行われるが、変位伝達部32として上述した材料を使用する場合には、アクチュエータ部本体30と変位伝達部32との接続は、接着剤を使って上述した材料の変位伝達部32を積層するか、上述した材料の溶液ないしスラリーをコーティングする等の方法によりアクチュエータ部本体30の上部に形成することにより行えばよい。

【0183】その後、変位伝達部32を概ねアクチュエータ部本体30の平面形状と同一となるように切断することは必ずしも必要ではない。但し、変位伝達部32における板部材32a又は変位伝達部材32bの材質によつては、アクチュエータ部本体30の変位を効率よくするために、変位伝達部32の層を切断するか、あるいは切欠きを設けることが好ましい。

【0184】組立後における変位伝達部32と光導波板12との所定距離は、アクチュエータ部本体30の変位量に比較して小さくする必要があるのはいうまでもないが、アクチュエータ部本体30の存在しない部分に所定の大きさの隙間形成部材を設けて、固定部24と光導波板12とを緊密に固定することが好ましい。

【0185】このように、本実施の形態に係る表示装置においては、上述したように、カラー表示方式に適用させる場合であっても、画素数を白黒画面の場合に比して増加させる必要がないという利点がある。

【0186】また、本実施の形態に係る表示装置は、変位伝達部32を選択的に変位させるアクチュエータ部本体30の構成として、振動部22上に形成された圧電/電歪層26の一主面に一対の電極28を形成するようにし、更に、圧電/電歪層26の一主面側に一対の電極28を形成するようにしているため、一対の電極28a及び28b間に空気又は変位伝達部32の構成材料（圧電

/電歪層26と比して誘電率が非常に小さい）が介在することとなる。そのため、アクチュエータ部本体30の静電容量は圧電/電歪層26の上下に電極を形成したものと比して小さくなり、それに伴い、信号伝達上のCR時定数も小さくなる。即ち、画像信号の属性に応じた電圧信号の信号波形になまりは生じにくくなる。

【0187】これにより、各画素における一対の電極28に選択的に規定電圧を印加することが可能となって、各圧電/電歪層26に必要な伸びを与えることができ、特に、電圧信号が供給される部分から遠い位置に配されたアクチュエータ部14に対応する部位（例えば画面周辺部や中央部等）において、表示輝度が弱くなるということも抑制される。

【0188】即ち、本実施の形態に係る表示装置においては、カラー表示方式に適用させた場合であっても画素数を白黒画面の場合に比して増加させる必要がないという利点に加えて、アクチュエータ部14での静電容量を低減することができるという利点を有し、表示画面全面に白色を表示させた場合に、むらのない表示輝度を得ることができ、画質の向上を図ることができる。

【0189】特に、本実施の形態に係る表示装置においては、図3及び図4に示すように、一対の電極28a及び28bのうち、垂直選択線40につながる一方の電極28aを1つの行に関してシリーズに接続したパターンとしているため、該一方の電極28aにおける外周部分の幅を広くとることが容易になり（破線で示す）、この場合、垂直選択線40の配線抵抗を小さくすることができ、信号伝達上のCR時定数を更に小さくすることができる。

【0190】そして、本実施の形態に係る表示装置においては、アクチュエータ部本体30の変位方向が図1上、上向き（光導波板12側の方向）であるため、アクチュエータ部本体30の変位の力をもって変位伝達部32を光導波板12に押し付けることができ、しかも、光導波板12とアクチュエータ部14との隙間（ギャップ）が調整しやすいことから、変位伝達部32と光導波板12との接触を確実にすることに対して有利となる。

【0191】また、例えば製造過程において、圧電/電歪層26の一部が絶縁破壊等によってその上の電極28の一部と共に消失した場合、圧電/電歪層26の補修を行わなくとも消失した電極28を補修するだけで十分にアクチュエータ部14として機能するため、製造工程の途中において全面作り直し等の無駄をなくすことができると共に、表示装置の歩留まりの向上を達成させることができる。

【0192】また、本実施の形態に係る表示装置においては、振動部22及び固定部24を基体18（セラミック）にて一体に形成し、振動部22に対応する箇所に空所20を形成して、振動部22が薄肉となるようにしているため、基体18に固定部24と振動部22を容易

に作製することが可能となり、表示装置の製造コストの低廉化を図る上で有利となる。

【0193】また、セラミックスにて構成される基体18に空所20を設けることによって厚肉の固定部24と薄肉の振動部22が形成されるかたちとなるため、振動部22は圧電／電歪層26の伸びに敏感に反応し、電圧信号の変化に対して追従性の高い振動部22とすることができます。また、両持ち構造や片持ち構造のアクチュエータ部と比較して、振動部22と固定部24との境部分の剛性が十分に確保されるため、振動部22の振動に伴う上記境部分の疲れによる破壊は発生しにくくなる。更に、基体18の剛性が高いため、光導波板12と駆動部16との貼り合わせも容易になる。

【0194】また、本実施の形態に係る表示装置においては、空所20及び圧電／電歪層26の各平面形状を共に角のとれた形状（本実施の形態に係る表示装置及び第1の変形例に係る表示装置では円形状、第2及び第3の変形例に係る表示装置では長円形状、第4の変形例に係る表示装置では楕円形状）とし、更に、空所20の平面形状の大きさを圧電／電歪層26のそれよりも大にしたので、振動部22と固定部24との境部分が空所20の平面形状と同様に角のとれた形状となり、振動部22の振動によって発生する応力が局部的に集中するということがなくなる。しかも、振動部22の周縁すべてが固定部24に支持され、振動部22の周縁部分での剛性を高くすることができる。その結果、上記境部分での疲れ限度を大幅に向上させることができ、アクチュエータ部14の長寿命化、ひいては表示装置の長寿命化を実現させることができる。

【0195】また、上記本実施の形態に係る表示装置においては、一対の電極28a及び28bにおける圧電／電歪層26上での平面形状を、一対の電極28a及び28bが互いに並行に、かつ相互に離間された渦巻き状に配線された形状としているため、一対の電極28a及び28bに所定の電圧が印加されると、圧電／電歪層26の一主面には放射状（等方的）に電界が生じ、そのため、圧電／電歪層26は、一主面では放射状（等方的）に伸びが生じる。このとき、圧電／電歪層26の深い部分では、表面部分の伸びよりも小さい伸びが放射状（等方的）に生じるか、あるいは縮みが放射状（等方的）に生じ、これにより、圧電／電歪層26は効率よくその中心部が凸となるように変位することになり、しかも、各画素間での変位上のばらつきも少なくなる。

【0196】また、一対の電極28a及び28bにおける圧電／電歪層26上での平面形状を多枝形状とした場合においては、上記実施の形態に係る表示装置と同様に、一対の電極28a及び28bに所定の電圧が印加された場合、圧電／電歪層26は、一主面では放射状（等方的）に伸びが生じる。このとき、圧電／電歪層26の深い部分では、表面部分の伸びよりも小さい伸びが放射

状（等方的）に生じるか、あるいは縮みが放射状（等方的）に生じることから、効率よくその中心部が凸となるよう変位し、各画素間での変位上のばらつきも少なくなる。特に、前記多枝形状を採用した場合においては、幹部52及び54と枝部56及び58とに分かれることになるため、圧電／電歪層26の一部、例えば枝部56又は58に対応する部分が絶縁破壊等によって該枝部56又は58と共に消失したとしても、他に与える影響は非常に小さく、幹部52及び54が残存している限り、アクチュエータ部14として十分に機能することとなる。もちろん、前記消失した電極の枝部56又は58を補修するだけで、消失前の機能に戻すことができ、表示装置に対する保守の簡易化を実現できる。

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【0197】また、本実施の形態に係る表示装置における第1の動作例においては、各アクチュエータ部14は、一対の電極28a及び28bに対して交番的に電圧を印加する状態（交番電圧印加状態）と電圧無負荷状態とを選択的に切り換えることにより、光導波板12の所定部位を発光させることができると（即ち、交番電圧印加状態でON選択、電圧無負荷状態でOFF選択）、画像情報をアクチュエータ部への駆動信号（電圧信号）に変換する際の制御性が高くなり、表示駆動動作を最適化し易い。その結果、低消費電力化や、表示輝度の向上及びちらつき等の抑制など、画質を向上させる上でも有利となる。

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【0198】本実施の形態に係る表示装置における第2の動作例においては、アクチュエータ部本体30を圧電／電歪層26と該圧電／電歪層26の一主面に形成された一対の電極28a及び28bとで構成し、更に、図16Bに示すように、前記一対の電極28a及び28b間の所定電界の4倍以上の印加電界によるアクチュエータ部14の変位特性を基準電界点を中心に非対称となるようにしたので、圧電／電歪層26に対して分極処理した後に逆方向に電界をかけた場合、圧電／電歪層26の表面付近においては、その電界強度が大きいことから、その分極方向が反転して前記電界の方向と同じになるが、圧電／電歪層26の深い部分はその電界強度が小さいことから、その分極方向は反転しないこととなる。即ち、前記圧電／電歪層26において、2種類の分極が存在することになり、擬似的なバイモルフ型のアクチュエータ部14として機能することになる。

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【0199】その結果、圧電／電歪層26の表面付近と、深い部分での歪み方向が互いに逆になり、全体として一方向に凸状変位し、その変位量は、前記擬似的なバイモルフ的な作用によって非常に大きいものとなる。

【0200】特に、本実施の形態に係る表示装置では、その屈曲変位特性が基準電界点（電界E=0の点）を中心にして電界の正方向と負方向とで非対称形となっていることから、例えば周期的に変化する電界の2つのピーク値におけるそれぞれの屈曲変位量において差が生じる。こ

れにより、電圧無負荷状態と電圧印加状態での相対変位量や、互いに逆方向の電界をかけた状態での相対変位量が大きくなる。従って、表示装置の画素単位に配列されるアクチュエータ部14とした場合に、これらアクチュエータ部14に対する制御が容易になり、表示装置における画質の向上を図る上で非常に有利になる。

【0201】また、本実施の形態に係る表示装置においては、一対の電極28a及び28b間の距離をx ($1 \mu m \leq x \leq 200 \mu m$)、前記圧電／電歪層26の厚みをy ($1 \mu m \leq y \leq 100 \mu m$)としたとき、 $y = ax$ の関係を有し、かつ、 $1/10 \leq a \leq 100$ として構成するようにしている。

【0202】この場合、前記一対の電極28a及び28b間の印加電界によるアクチュエータ部14の変位特性として、図16Bに示すように、基準電界点（電界E=0の点）を中心に非対称となる特性を得ることができる。

【0203】また、本実施の形態に係る表示装置においては、前記振動部22及び固定部24をセラミックスにて一体に形成し、振動部22に対応する箇所に空所20を形成して、該振動部22が薄肉となるようにしたので、固定部24と振動部22を容易に作製することができる、表示装置の製造コストの低廉化を図る上で有利となる。

【0204】また、本実施の形態に係る表示装置においては、圧電／電歪層26の厚みをy ($1 \mu m \leq y \leq 100 \mu m$)、振動部22の厚みをz ($1 \mu m \leq z \leq 50 \mu m$)としたとき、 $y = bz$ の関係を有し、かつ、 $1/5 \leq b \leq 10$ としたので、一対の電極28a及び28b間の印加電界によるアクチュエータ部14の屈曲変位特性を図12Bに示すように、基準電界点を中心に非対称とすることが可能となる。

【0205】本実施の形態に係る表示装置においては、特に一対の電極28a及び28bの平面形状を渦巻き形状や多枝形状としたが、図28に示すように、くし型形状であってもかまわない。この場合、振動部22の形状を縦横比（アスペクト比）で0.25以下又は4.0以上とし、多数のくし歯部分の配列方向が振動部22の長手方向に沿うように一対のくし型電極を形成する方が好ましい。この条件を満足すれば、一対の電極28a及び28bがくし型形状であっても、前記渦巻き形状や多枝形状と同様の効果を得ることができる。

【0206】ただし、振動部22の形状がアスペクト比で0.25～4.0、好ましくは0.5～2.0であって、一対の電極28a及び28bの平面形状が渦巻き形状又は多枝形状とするのが、相対変位量を大きくする上で最も好ましい。

【0207】また、前記実施の形態に係る表示装置においては、図1に示すように、基体18を基板層18Aとスペーサ層18Bと薄板層18Cの積層体で構成するよ

うにしたが、その他、図29に示すように、最下層の基板層18Aを省略するようにしてもよい。

【0208】上記本実施の形態に係る表示装置及びその変形例に係る表示装置においては、その光導波板12として両面が高い平坦度、平滑度を持ったものを使用したが、その他、背面側が粗面処理されたいわゆるスリガラスを用いることも可能である。この場合、変位伝達部32の一主面（スリガラスの背面に対向する面）をスリガラスの背面における粗面形状に沿った粗面処理を施すか、あるいは変位伝達部32の上記一主面部分を粘性が比較的低いエラストマにて構成する。

【0209】これにより、まず、正面からの入射した光がスリガラスの粗面によって反射されて散乱光としてスリガラスの前面方向に透過する。この状態において、あるアクチュエータ部14が電圧印加状態あるいはON選択状態とされて、スリガラスの背面に上記アクチュエータ部14に対応する変位伝達部32が接触すると、当該接触部分の粗面が変位伝達部32の粗面あるいは弾性変形によって打ち消された形となるため、それまでスリガラスの上記粗面部分にて反射していた光は、スリガラスの背面に接触している変位伝達部32を透過することとなる。

【0210】つまり、光導波板12としてスリガラスを用いた場合も、スリガラスの背面にある変位伝達部32の接触の有無により、スリガラスの前面における光の発光の有無を制御することができ、上述した本実施の形態に係る表示装置やその変形例に係る表示装置と同じ効果を得ることができる。特に、上記スリガラスを用いた場合は、スリガラスに対して光を積極的に導入させる照明手段が不要となるため、構成がより簡略化される。

【0211】なお、本発明に係る表示装置を、本実施の形態に係る表示装置並びに第1～第4の変形例に係る表示装置に基づいて具体的に説明してきたが、本発明は、上記実施の形態並びに変形例に限定されて解説されるものではなく、本発明の範囲を逸脱しない限りにおいて、種々なる変更、修正、改良等を加えうるものである。

【0212】

【発明の効果】以上説明したように、本発明に係る表示装置によれば、光が導入される光導波板と、該光導波板の一方の板面に對向して設けられ、かつ多数の画素に対応した数のアクチュエータ部が配列された駆動部とを具備し、入力される画像信号の属性に応じて前記光導波板に対する前記アクチュエータ部の接触・離隔方向の変位動作を制御して、前記光導波板の所定部位の漏れ光を制御することにより、前記光導波板に前記画像信号に応じた映像を表示させる表示装置において、前記アクチュエータ部を、圧電／電歪層と、該圧電／電歪層の一主面に形成された一対の電極とを有するアクチュエータ部本体と、前記圧電／電歪層の他主面に接して前記アクチュエータ部本体を支持する振動部と、前記振動部を振動可能

に支持する固定部と、前記一対の電極への電圧印加によって生じるアクチュエータ部本体の変位動作を光導波板に伝達する変位伝達部とで設けるようにしている。

【0213】このため、カラー表示方式に適用させた場合であっても画素数を白黒画面の場合に比して増加させる必要がないという利点に加えて、アクチュエータ部での静電容量を低減することができるという利点を有し、表示画面全面に白色を表示させた場合に、むらのない表示輝度を得ることができ、画質の向上を図ることができるという効果が達成される。

【0214】特に、前記一対の電極間の所定電界の4倍以上の印加電界による前記アクチュエータ部の屈曲変位特性を、基準電界点を中心に非対称にすることにより、電圧無負荷状態と電圧印加状態での相対変位量や、互いに逆方向の電界をかけた状態での相対変位量が大きくなる。

【0215】のことから、表示装置の画素単位に配列されるアクチュエータ部に対する制御が容易になり、表示装置における画質の向上を図る上で非常に有利になる。

【図面の簡単な説明】

【図1】本実施の形態に係る表示装置を示す構成図である。

【図2】本実施の形態に係る表示装置におけるアクチュエータ部（画素）の配置を拡大して示す平面図である。

【図3】本実施の形態に係る表示装置、特に一対の電極の平面形状（渦巻き状）を示す平面図である。

【図4】本実施の形態に係る表示装置の第1の変形例、特に一対の電極の平面形状（多枝形状）を示す平面図である。

【図5】本実施の形態に係る表示装置の第2の変形例、特に振動部、圧電／電歪層及び一対の電極の平面形状（長円形状、渦巻き状）を示す平面図である。

【図6】本実施の形態に係る表示装置の第3の変形例、特に振動部、圧電／電歪層及び一対の電極の平面形状（長円形状、多枝形状）を示す平面図である。

【図7】本実施の形態に係る表示装置の第4の変形例におけるアクチュエータ部（画素）の配置を拡大して示す平面図である。

【図8】本実施の形態に係る表示装置の第5の変形例におけるアクチュエータ部（画素）の配置を拡大して示す平面図である。

【図9】本実施の形態に係る表示装置の第6の変形例におけるアクチュエータ部（画素）の配置を拡大して示す平面図である。

【図10】本実施の形態に係る表示装置におけるアクチュエータ部の圧電／電歪層をリング状とした場合を概略的に示す平面図である。

【図11】図10におけるA-A線上の断面図である。

【図12】本実施の形態に係る表示装置におけるアクチ

ュエータ部において、圧電／電歪層の平面形状を円環状とし、一対の電極を多枝形状とした例を示す平面図である。

【図13】図13 Aはリング状の圧電／電歪層の外周形状を円形とした場合を示す平面図であり、図13 Bはリング状の圧電／電歪層の外周形状を橢円形とした場合を示す平面図であり、図13 Cはリング状の圧電／電歪層の外周形状を矩形とした場合を示す平面図である。

【図14】本実施の形態に係る表示装置における第1の動作例でのアクチュエータ部の変位原理を示す作用図である。

【図15】本実施の形態に係る表示装置のアクチュエータ部をON選択状態としたときに、一対の電極間に印加される交番信号の一例を示す信号波形図である。

【図16】図16 Aは本実施の形態に係る表示装置におけるアクチュエータ部の屈曲変位特性を測定するためには、一対の電極に印加すべき電位波形を示すタイミングチャートであり、図16 Bはアクチュエータ部の屈曲変位特性を示す特性図である。

【図17】図17 Aは圧電／電歪層に対して初期分極処理を行った場合の分極方向と電界方向を示す説明図であり、図17 Bは一対の電極に対する電圧印加を停止した状態（電圧無負荷状態）での分極方向を示す説明図である。

【図18】図18 Aは本実施の形態に係る表示装置のアクチュエータ部に対して正方向に電界（+3E）をかけた状態の分極方向と電界方向を示す説明図であり、図18 Bはアクチュエータ部に対して負方向の所定電界（-0.6E）をかけた状態の分極方向と電界方向を示す説明図である。

【図19】図19 Aは本実施の形態に係る表示装置のアクチュエータ部に対して負方向に電界（-3E）をかけた状態の分極方向と電界方向を示す説明図であり、図19 Bはアクチュエータ部に対して正方向の所定電界（+0.6E）をかけた状態の分極方向と電界方向を示す説明図である。

【図20】本実施の形態に係る表示装置における各アクチュエータ部の一対の電極間の距離と圧電／電歪層の厚みとの寸法関係を示す特性図である。

【図21】図21 Aは一対の電極の平面形状が渦巻き状である場合の電極間距離を示す説明図であり、図21 Bは一対の電極の平面形状が多枝形状である場合の電極間距離を示す説明図である。

【図22】本実施の形態に係る表示装置における各アクチュエータ部の振動部の厚みと圧電／電歪層の厚みとの寸法関係を示す特性図である。

【図23】図23 Aはアクチュエータ部の最短寸法での断面形状を一部省略して示す断面図であり、図23 Bは一方の最外極小点と他方の最外極小点が固定部の上面よりも下方に存在する場合を一部省略して示す断面図であ

り、図23Cは一方の最外極小点と他方の最外極小点が固定部の上面よりも上方に存在する場合を一部省略して示す断面図である。

【図24】図24Aは他方の極小点存在領域内に他方の最外極小点が存在せず、他方の境界点が他方の最外極小点として認定される場合の例を一部省略して示す断面図であり、図24Bは両方の極小点存在領域内にそれぞれ最外極小点が存在せず、一方の境界点及び他方の境界点がそれぞれ一方の最外極小点及び他方の最外極小点として認定される場合の例を一部省略して示す断面図である。

【図25】図25Aはアクチュエータ部における非選択状態とON選択状態での電圧レベルの変化を示すタイミングチャートであり、図25Bはアクチュエータ部における非選択状態とOFF選択状態での電圧レベルの変化を示すタイミングチャートである。

【図26】図26Aは本実施の形態に係る表示装置をカラー表示方式に適用する場合のRGBの発光時間の比率を1:1:1とした場合のタイミングチャートであり、図26Bは前記RGBの発光時間の比率を4:1:5とした場合のタイミングチャートである。

【図27】本実施の形態に係る表示装置による大画面表示装置を背面側から見て示す斜視図である。

【図28】本実施の形態に係る表示装置におけるアクチュエータ部の一対の電極の平面形状をくし型形状とした場合の好適な例を示す平面図である。

【図29】本実施の形態に係る表示装置において、基体の他の構造例を示す構成図である。

【図30】提案例に係る表示装置を示す構成図である。

【図31】図31Aは提案例に係る表示装置におけるアクチュエータ部の屈曲変位特性を測定するために、上部電極及び下部電極に印加すべき電位波形を示すタイミングチャートであり、図31Bはアクチュエータ部の屈曲変位特性を示す特性図である。

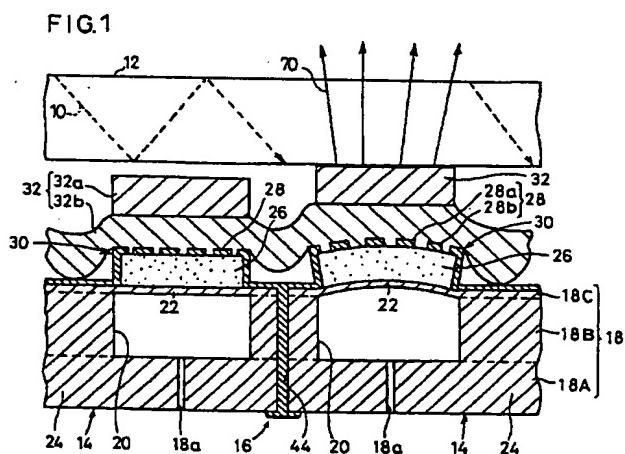
【図32】図32Aは提案例に係る表示装置のアクチュエータ部に対して正方向に電界(+3E)をかけた状態の分極方向と電界方向を示す説明図であり、図32Bはアクチュエータ部に対して負方向の所定電界(-0.5E)をかけた状態の分極方向と電界方向を示す説明図である。

【図33】図33Aは提案例に係る表示装置のアクチュエータ部に対して負方向に電界(-3E)をかけた状態の分極方向と電界方向を示す説明図であり、図33Bはアクチュエータ部に対して正方向の所定電界(+0.5E)をかけた状態の分極方向と電界方向を示す説明図である。

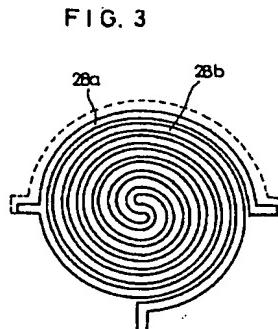
【符号の説明】

| | |
|---------------|------------|
| 10…光 | 12…光導波板 |
| 14…アクチュエータ部 | 16…駆動部 |
| 18…基体 | 20…空所 |
| 22…振動部 | 24…固定部 |
| 26…圧電/電歪層 | 28…一対の電極 |
| 28a…一方の電極 | 28b…他方の電極 |
| 30…アクチュエータ部本体 | 32…変位伝達部 |
| 32a…板部材 | 32b…変位伝達部材 |
| 40…垂直選択線 | 42…信号線 |
| 44、46…スルーホール | |

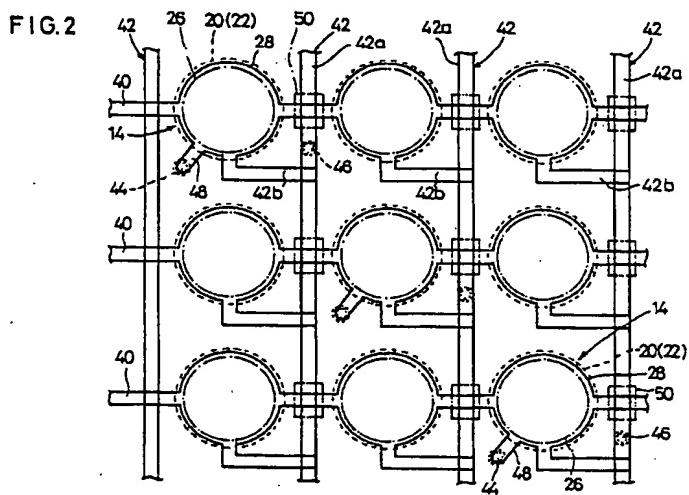
【図1】



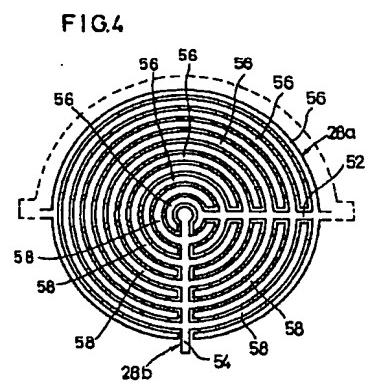
【図3】



【図2】

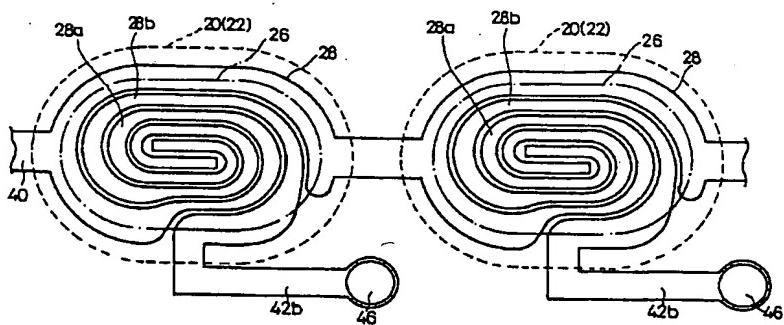


【図4】

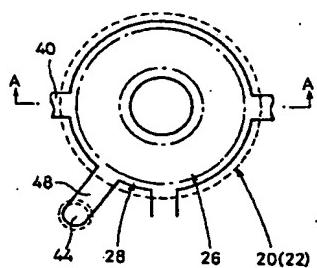


【図5】

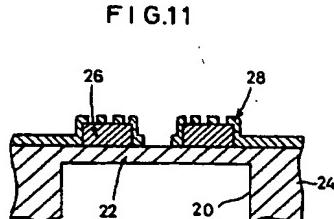
FIG.5



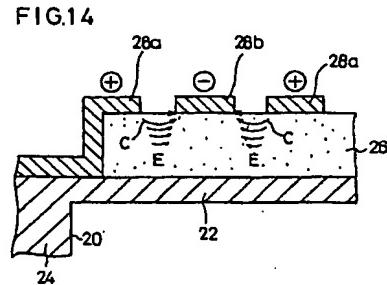
【図10】



【図11】

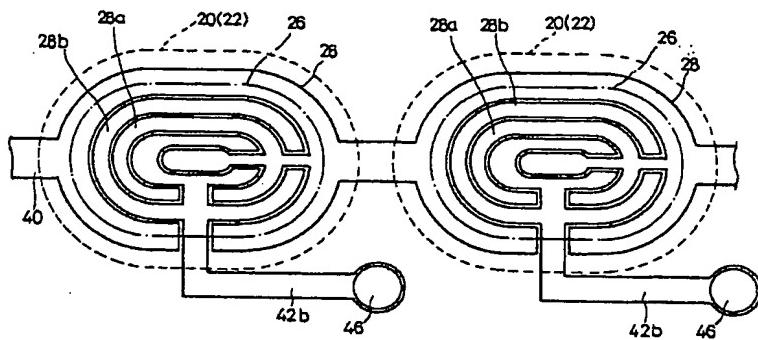


【図14】



【図6】

FIG. 5

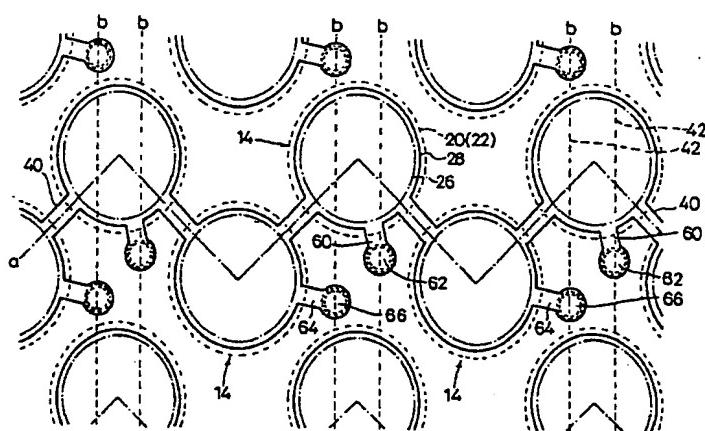


【図7】

【図12】

FIG. 7

FIG.12



【図13】

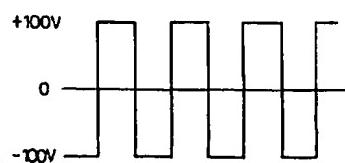
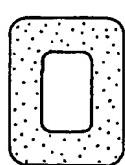
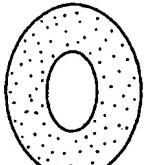
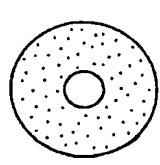
【図15】

FIG.13A

FIG.13B

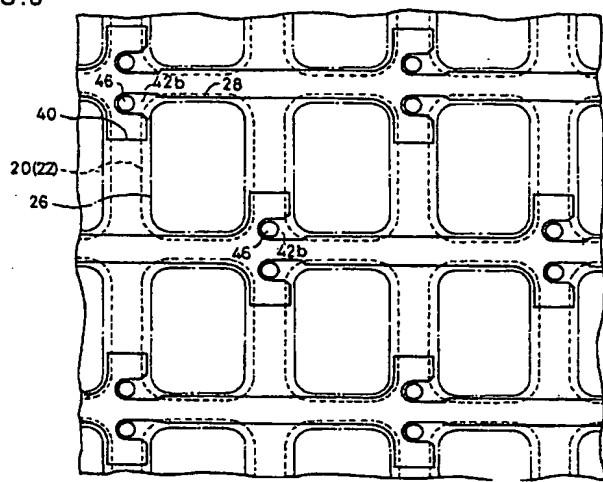
FIG.13C

FIG.15



【図8】

FIG.8



【図23】

FIG.23A

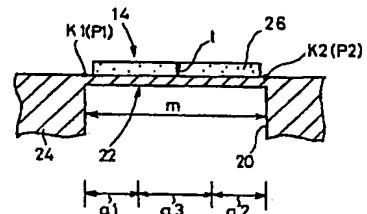


FIG.23B

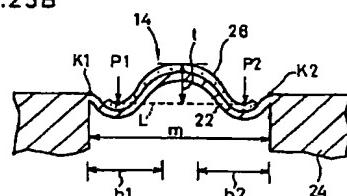
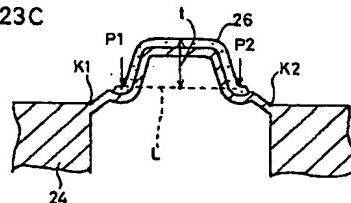
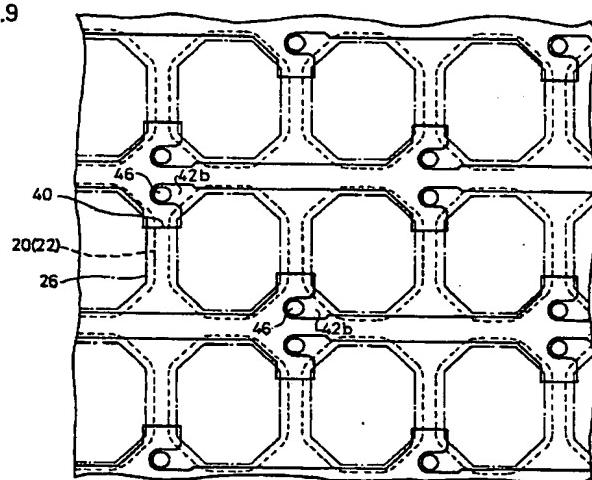


FIG.23C



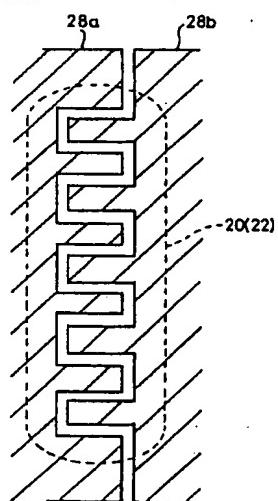
【図9】

FIG.9



【図28】

FIG.28



【図16】

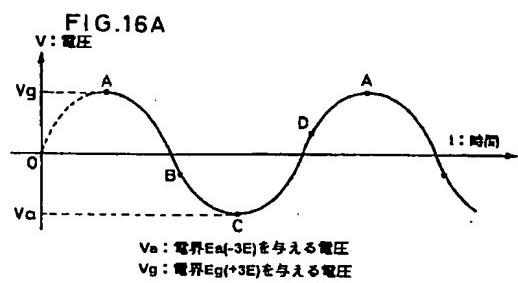


FIG.16B

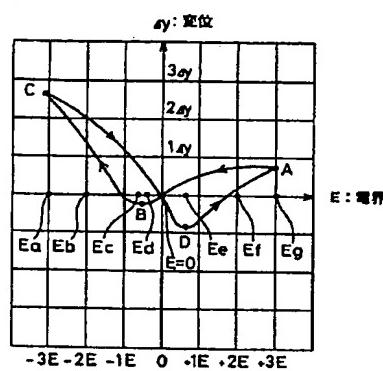


FIG.17A

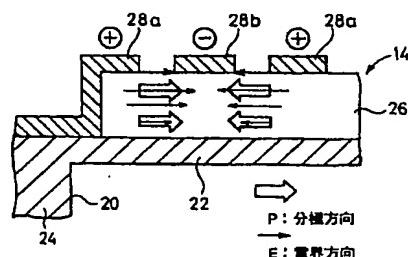
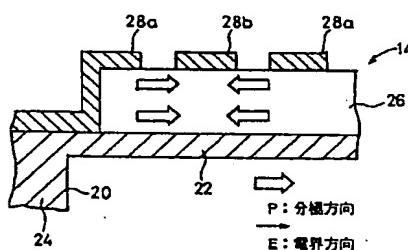
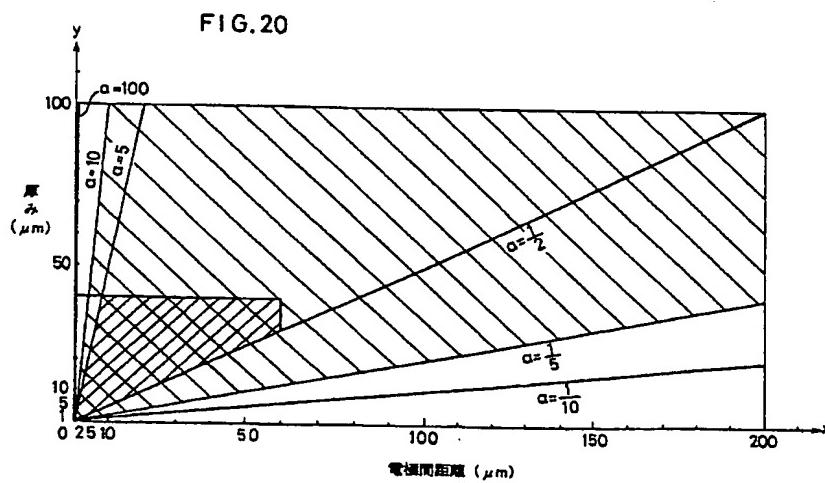


FIG.17B

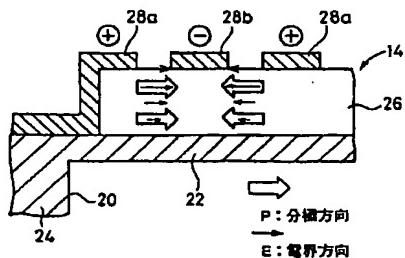


【図20】



【図18】

FIG.18A



【図19】

FIG.19A

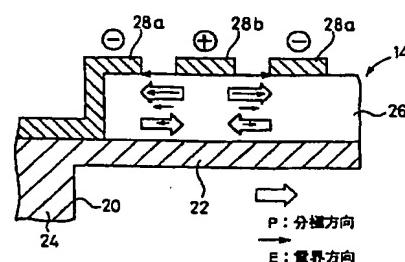


FIG.18B

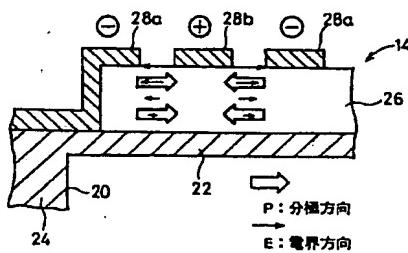
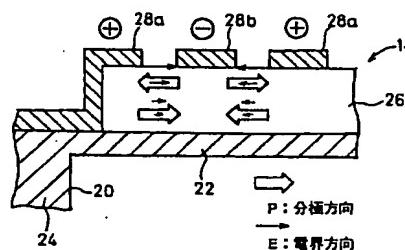


FIG.19B



【図21】

FIG.21A

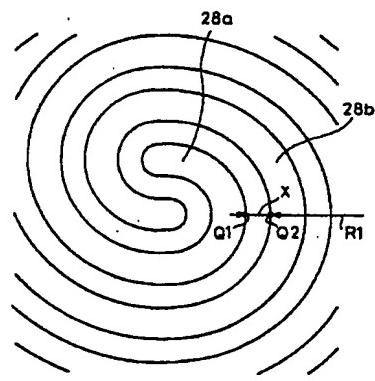
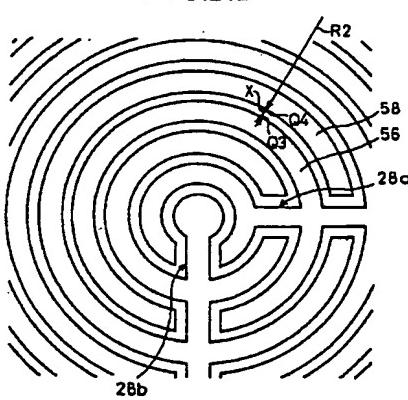
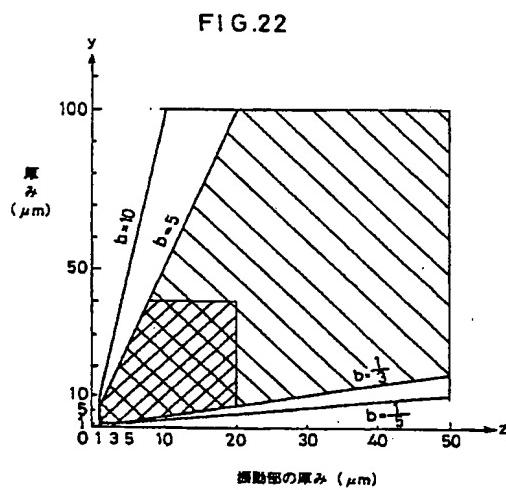


FIG.21B



【図22】



【図25】

FIG.25A

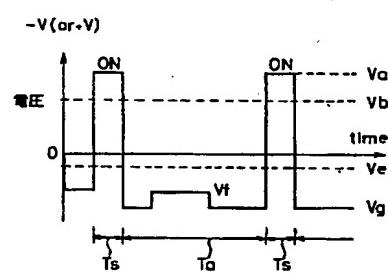
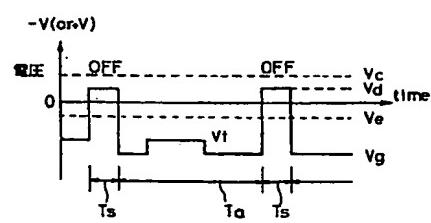


FIG.25B



【図24】

FIG.24A

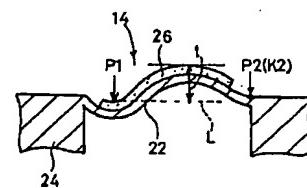
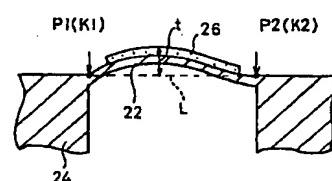


FIG.24B



【図26】

FIG.26A

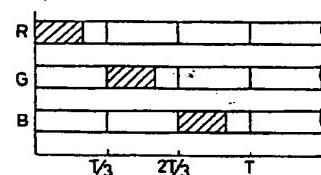
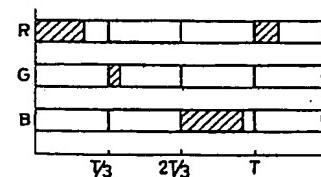
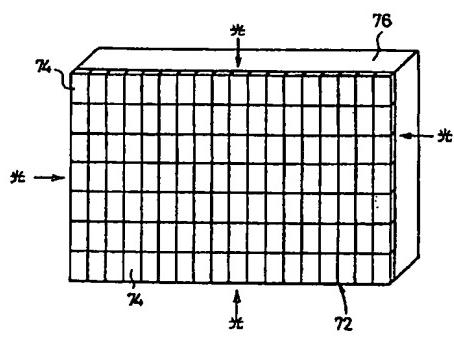


FIG.26B



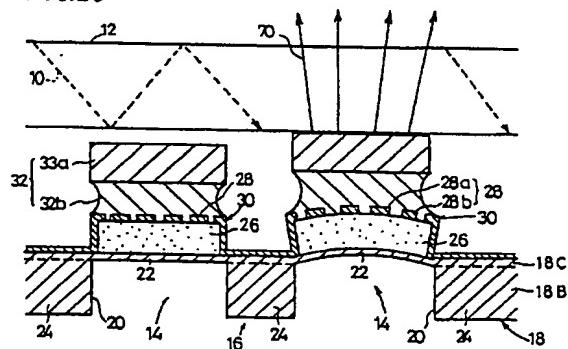
【図27】

FIG.27



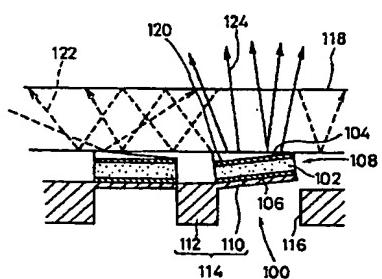
【図29】

FIG.29



【図30】

FIG.30



【図31】

FIG.31A

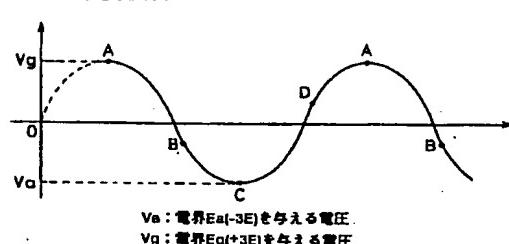
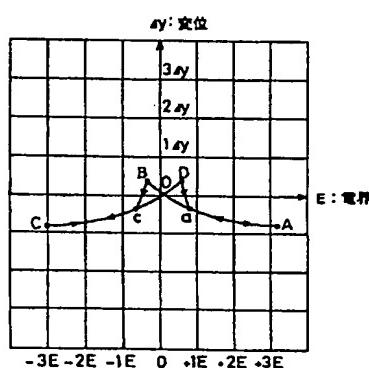


FIG.31B



【図32】

FIG.32A

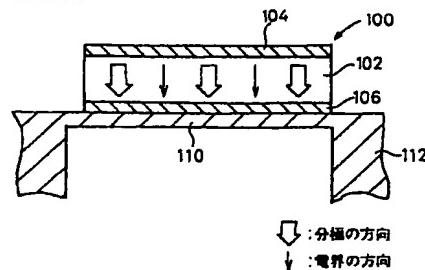
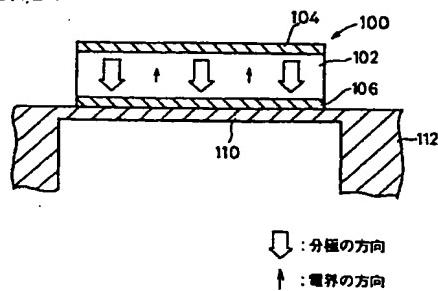


FIG.32B



【図33】

FIG.33A

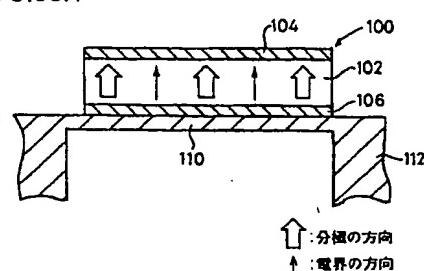
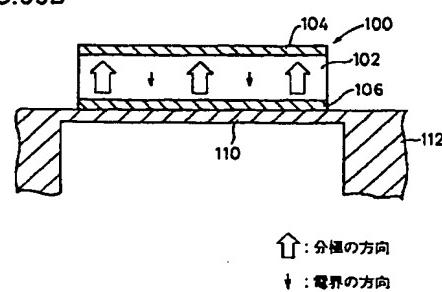


FIG.33B



フロントページの続き

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JAPANESE

[JP,10-078549,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION
TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS CORRECTION OR
AMENDMENT

[Translation done.]

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CLAIMS

[Claim(s)]

[Claim 1] It is prepared in one plate surface of the photoconductive corrugated plate into which light is introduced, and this photoconductive corrugated plate face to face. And provide the mechanical component by which the actuator section of the number corresponding to many pixels was arranged, and displacement actuation of the contact / isolation direction of said actuator section to said photoconductive corrugated plate is controlled according to the attribute of the picture signal inputted. In the indicating equipment which displays the image according to said picture signal on said photoconductive corrugated plate by controlling the leakage light of the predetermined part of said photoconductive corrugated plate said actuator section The actuator section body which has piezo-electricity / electrostriction layer, and the electrode of the pair formed in one principal plane of this piezo-electricity / electrostriction layer, The oscillating section which supports said actuator section body in contact with the other principal planes of said piezo-electricity / electrostriction layer, The display characterized by having the displacement transfer section which transmits displacement actuation of said actuator section which possesses the fixed part which supports said oscillating section possible [vibration], and is produced by electrical-potential-difference impression to the electrode of said pair to a photoconductive corrugated plate.

[Claim 2] The display characterized by forming said oscillating section and said fixed part in one with the ceramics, forming dead air space in the part corresponding to said oscillating section in a display according to claim 1, and using this oscillating section as thin meat.

[Claim 3] The display with which each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer are configurations where the angle was able to be taken, in a display according to claim 2, and magnitude of the flat-surface configuration of said dead air space is characterized by being size rather than that of piezo-electricity / electrostriction layer.

[Claim 4] The display characterized by each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer being circular in a display according to claim 3.

[Claim 5] The display characterized by each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer being ellipse configurations in a display according to claim 3.

[Claim 6] The display with which each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer are rectangles-like, and the corner section is characterized by being the configuration where the angle was able to be taken in a display according to claim 3.

[Claim 7] The display characterized by for each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer being polygons-like, and being the configuration where each vertical-angle part was roundish in a display according to claim 3.

[Claim 8] It is the display characterized by making the flat-surface configuration on said piezo-electricity / electrostriction layer into the curled form by which it was estranged mutually in parallel [the electrode of these pairs]. [in / on a display given in any 1 term of claims 1-7, and / the electrode of said pair]

[Claim 9] It is the display characterized by being the configuration which it has the configuration which branched from the management to whom the flat-surface configuration on said piezo-electricity / electrostriction layer in the electrode of said pair both extends toward the core on said piezo-electricity / electrostriction layer in a display given in any 1 term of claims 1-7, and the electrode of said pair was estranged mutually, and was arranged by the complementary.

[Claim 10] The display characterized by impressing the signal which makes any 1 term of claims 1-9 reverse the direction of polarization of said piezo-electricity / electrostriction layer to inter-electrode [of said pair] in the display of a publication, removing spontaneous distortion, and driving said actuator section.

[Claim 11] crookedness of said actuator section according [on an indicating equipment given in any 1 term of claims 1-9, and] to the impression electric field of 4 times or more of the inter-electrode predetermined electric field of said pair -- a variation rate -- the indicating equipment with which a property is characterized by the unsymmetrical thing a core [a criteria electric-field point].

[Claim 12] the crookedness when impressing the electric field of 4 times or more of two predetermined electric fields from which an absolute value is the same as that of, and a direction differs on the basis of said criteria electric-field point in a display according to claim 11, respectively -- a variation rate -- the display characterized by having the relation of $A >= 1.5B$ when an amount is set to A and B.

[Claim 13] The display characterized by impressing an electrical potential difference in the direction whose amount of displacement of the one direction in said crookedness displacement property is max to the actuator section which should be considered as ON selection among the actuator sections of said large number in a display according to claim 11 or 12 about the predetermined electrical-potential-difference range impressed to the electrode of said pair.

[Claim 14] The display characterized by impressing an electrical potential difference in the direction whose amount of displacement of the one direction in said crookedness displacement property is min to the actuator section which should be considered as OFF selection among the actuator sections of said large number in a display according to claim 11 or 12 about the predetermined electrical-potential-difference range impressed to the electrode of said pair.

[Claim 15] The display characterized by impressing an electrical potential difference in the direction whose amount of displacement of the one direction in said crookedness displacement property is min to the actuator section which it should presuppose un-choosing among the actuator sections of said large number in a display according to claim 11 or 12 about the predetermined electrical-potential-difference range impressed to the electrode of said pair.

[Claim 16] The display which has the relation of $y = ax$ and is characterized by being $1 / 10 <= a <= 100$ in a display given in any 1 term of claims 1-15 when thickness of x (1 micrometer $<= x <= 200$ micrometer), and said piezo-electricity / electrostriction layer is set to y (1 micrometer $<= y <= 100$ micrometer) for an inter-electrode distance of said pair.

[Claim 17] The display characterized by being $1 / 5 <= a <= 10$ in a display according to claim 16.

[Claim 18] The display characterized by being $1 / 2 <= a <= 5$, and being $1 \text{ micrometer} <= x <= 60 \text{ micrometer}$ and $1 \text{ micrometer} <= y <= 40 \text{ micrometer}$ in a display according to claim 17.

[Claim 19] The display which has the relation of $y = bz$ and is characterized by being $1 / 5 <= b <= 10$ in the display of claim 16-18 given in any 1 term when thickness of said oscillating section is set to z (1 micrometer $<= z <= 50$ micrometer).

[Claim 20] The display characterized by being $1 / 3 <= b <= 5$ in a display according to claim 19.

[Claim 21] The display characterized by being $1 / 3 <= b <= 5$, and being $1 \text{ micrometer} <= y <= 40 \text{ micrometer}$ and $1 \text{ micrometer} <= z <= 20 \text{ micrometer}$ in a display according to claim 20.

[Claim 22] The display with which the cross-section configuration in the shortest dimension passing through the core of said oscillating section is characterized by satisfying the conditions of the following [electrical-potential-difference unloaded condition] in a display given in any 1 term of claims 10-21.

(1) From the datum line which while approaches said fixed part and is constituted by connecting the outermost minimum point and the outermost minimum point of another side, a part of top face [at least] in near the center section of said the piezo-electricity / electrostriction layer has projected to said oscillating section and opposite direction.

(2) When said outermost minimum point does not exist, make the point corresponding to the boundary point with said fixed part into the outermost minimum point among the top faces of the oscillating section which meet said shortest dimension.

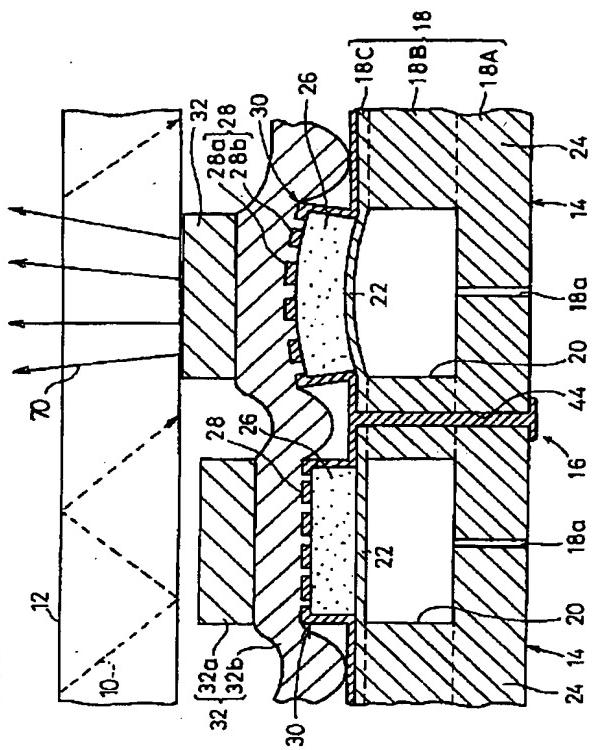
(3) When a boundary part with said fixed part of said oscillating section is made into zero point, the shortest dimension length of said oscillating section is set to 100 and said outermost minimum point cannot be found in 40% of range of the shortest dimension length in said oscillating section from said zero point, make the point corresponding to the boundary point with said fixed part into the minimum minimum point among the top faces in alignment with said oscillating section.

[Claim 23] The display characterized by said amount t of protrusions being $1000 <= t <= m$ [$m / 10$ in a display according to claim 22.

[Translation done.]

Drawing selection Representative drawing

FIG.1



[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Power consumption of this invention is small and it relates to amelioration of the indicating equipment which displays the image according to a picture signal on a photoconductive corrugated plate by controlling displacement actuation of the contact / isolation direction of the actuator section to a photoconductive corrugated plate according to the attribute of the picture signal especially inputted about the big indicating equipment of screen intensity, and controlling the leakage light of the predetermined part of a photoconductive corrugated plate.

[0002]

[Description of the Prior Art] From the former, displays, such as a cathode-ray tube (CRT) and a liquid crystal display, are known as a display.

[0003] As a cathode-ray tube, although the usual television receiver, the monitoring device for computers, etc. are known, and a screen is bright, there is a problem that power consumption is large and the depth of the whole display becomes large as compared with the magnitude of a screen.

[0004] On the other hand, although a liquid crystal display can miniaturize the whole equipment and has the advantage that there is little power consumption, the brightness of a screen is inferior in it and it has the problem that whenever [screen angle-of-visibility] is narrow.

[0005] Furthermore, in these cathode-ray tubes or a liquid crystal display, when making it a color screen, the number of pixels had to be increased 3 times of monochrome screen, for this reason, equipment itself became complicated, power consumption increased, and there was also a problem that a cost rise was not avoided.

[0006] Then, these people proposed the new display so that they may solve the above-mentioned problem (for example, refer to JP,7-287176,A). As this indicating equipment is shown in drawing 30, it has the actuator section 100 arranged for every pixel. Each actuator section 100 The actuator section body 108 possessing the up electrode 104 formed in the top face and inferior surface of tongue of piezo-electricity / electrostriction layer 102, and this the piezo-electricity / electrostriction layer 102, respectively, and the lower electrode 106, It has the base 114 which consists of the oscillating section 110 arranged by the lower part of this actuator section body 108, and a fixed part 112, and is constituted. The lower electrode 106 of the actuator section body 108 contacts the oscillating section 110, and the above-mentioned actuator section body 108 is supported by this oscillating section 110.

[0007] The oscillating section 110 and a fixed part 112 are united, the above-mentioned base 114 consists of ceramics, and further, the crevice 116 is formed in the base 114 so that the above-mentioned oscillating section 110 may become thin meat.

[0008] Moreover, the displacement transfer section 120 for making a touch area with the photoconductive corrugated plate 118 into predetermined magnitude is connected to the up electrode 104 of the actuator section body 108. the example of drawing 30 -- the above -- a variation rate -- in OFF selection or the condition of not choosing that the actuator section 100 is standing it still, the transfer section 120 approaches the photoconductive corrugated plate 118, is arranged, and it is arranged so that the above-mentioned photoconductive corrugated plate 118 may be contacted in the distance below the wavelength of light in ON selection condition.

[0009] And the light 122 of the above-mentioned photoconductive corrugated plate 118 is introduced from an edge. In this case, total reflection is carried out inside by adjusting the magnitude of the refractive index of the photoconductive corrugated plate 118, without all the light 122 penetrating in the front face and tooth back of the photoconductive corrugated plate 118. In this condition, the voltage signal according to the attribute of a picture signal is alternatively impressed to the actuator section 100 through the above-mentioned up electrode 104 and the lower electrode 106. this actuator section 100 -- the various kinds of ON selection, OFF selection, and not choosing -- a variation rate -- by making it operate The contact and elongation to the photoconductive corrugated plate 118 of the above-mentioned displacement transfer section 120 are controlled, thereby, the scattered light (leakage light) 124 of the predetermined part of the above-mentioned photoconductive corrugated plate 118 is controlled, and the

display of the image according to a picture signal is made by the photoconductive corrugated plate 118.

[0010] According to this display, it is (1). That power consumption can be lessened and (2) That screen intensity can be enlarged and (3) When making it a color screen, it has advantages -- it is not necessary to make the number of pixels increase as compared with the case of monochrome screen etc..

[0011]

[Problem(s) to be Solved by the Invention] By the way, in the indicating equipment concerning the above-mentioned example of a proposal, since the configuration of the actuator section body 108 be make into the so-called sandwich structure which formed the up electrode 104 and the lower electrode 106 in piezo-electricity / electrostriction layer 102, the electrostatic capacity in the actuator section body 108 surely become large, and, moreover, there be a possibility of say that CR time constant on signal transduction become large by relation with the wiring resistance between the actuator section bodies 108.

[0012] If the above-mentioned CR time constant becomes large, a provincial accent will arise in the signal wave form of a voltage signal according to the attribute of a picture signal, and the problem that specified voltage cannot be impressed to each electrode will occur. This leads to the ability of a distortion required for piezo-electricity / electrostriction layer 102 not to be given, and has a possibility that display brightness may become weak, in the parts (for example, a screen periphery, a center section, etc.) corresponding to the actuator section 100 allotted to the location distant from the part to which a voltage signal is supplied especially.

[0013] moreover, crookedness of the actuator section 100 which consists of the actuator section body 108, the oscillating section 110, and the fixed part 112 of sandwich structure in the indicating equipment concerning said example of a proposal -- a variation rate -- when a property is see, as show in drawing 31 B, it has a symmetry form in the forward direction and the negative direction of electric field focusing on the criteria electric-field point (point of electric field $E=0$). Here, crookedness displacement makes the negative direction the case where the case where the actuator section 100 displaces to convex to an one direction (direction which the up electrode 104 formed on piezo-electricity / electrostriction layer 102 faces free space) is displaced to the forward direction and a concave.

[0014] After this displacement property's impressing a predetermined electrical potential difference between the up electrode 104 and the lower electrode 106 and carrying out polarization processing of piezo-electricity / the electrostriction layer 102, the electric field added to the actuator section 100 see the variation rate of the actuator section 100 when changing continuously the electrical potential difference impressed between the up electrode 104 and the lower electrode 106 so that it may become the electric field of $+3E \rightarrow -3E \rightarrow +3E$.

[0015] That is, after carrying out polarization processing of piezo-electricity / the electrostriction layer 102 first to the actuator section 100, applying the electric field for polarization (for example, $+5E$) in the forward direction, electrical-potential-difference impression of a between [the up electrode 104 and the lower electrode 106] is stopped, and it considers as electrical-potential-difference unloaded condition. and measurement initiation -- the actuator section 100 -- the sine wave (refer to drawing 31 A) of the frequency of 1Hz, and peak value** $3E$ -- impressing -- the variation rate in each point at that time (Point A - Point D) -- an amount is continuously measured using a laser displacement gage. It is the property Fig. of drawing 31 B which plotted the measurement result at that time in the electric-field-crookedness displacement graph. it is shown in the arrow head of drawing 31 B -- as -- crookedness -- the variation rate of a variation rate -- the amount is changing with the continuous changes in electric field continuously.

[0016] Since electric field will be concretely impressed in the direction of polarization, and the same direction first at the actuator section 100 as shown in drawing 32 A supposing it starts said measurement from electric-field $+3E$, piezo-electricity / electrostriction layer 102 produces shrinkage in the parallel direction with elongation, the up electrode 104, and the lower electrode 106 in the up electrode 104 and the direction between the lower electrodes 106. Consequently, the whole actuator section displaces 0.9deltay in the negative direction.

[0017] Then, if electric field are changed to $-0.5E$ from $+3E$, the amount of displacement decreases gradually. Since electric field will be built over the sense and opposite direction of polarization as shown in drawing 32 B if electric field become in the negative direction, piezo-electricity / electrostriction layer 102 generates elongation in the direction parallel to the up electrode 104 and the lower electrode 106, and the variation rate changes in the forward direction.

[0018] Next, if electric field are changed to $-0.5E \rightarrow -3E$, the sense of polarization will begin to be reversed gradually. That is, the sense of electric field and the sense of polarization begin to gather. It is thought that polarization is completely reversed mostly at Point c among the point B-> point c-> points C of drawing 31 B. The reason is because a hysteresis is not seen between Point c - Point C.

[0019] And as shown in drawing 33 A, when the sense of electric field and the sense of polarization gather, piezo-electricity / electrostriction layer 102 changes to the condition of being shrunken from the condition of being extended horizontally. In the phase in which electric field became $-3E$, the amount of displacement becomes almost the same as the amount of displacement at the measurement initiation time (0.9deltay).

[0020] That is, when the direction of polarization and the direction of electric field are in agreement, piezo-

electricity / electrostriction layer 102 becomes what is shrunken by the parallel direction of electrodes 104 and 106 (extended in an electrode 104 and the direction between 106), and, as for this, the condition of Point A and Point C corresponds. Moreover, when the direction of polarization and the direction of electric field are opposite sense, piezo-electricity / electrostriction layer 102 becomes what is extended to the parallel direction of electrodes 104 and 106 (shrunken in an electrode 104 and the direction between 106), and, as for this, the condition of Point B and Point D corresponds. 1 [in addition,] -- E = about 1.7kV [mm]/and 1delta -- it is y = about 1.6 micrometers. [0021] Then, electric field - If it is made to change to +0.5E from 3E, the amount of displacement will decrease gradually, since electric field will be built over the sense and opposite direction of polarization as shown in drawing 33 B if electric field become in the forward direction, piezo-electricity / electrostriction layer 102 generates elongation in the direction parallel to the up electrode 104 and the lower electrode 106, and the variation rate changes in the forward direction.

[0022] And if electric field are changed to +0.5E->+3E, when the sense of polarization will begin to be reversed gradually and the sense of electric field and the sense of polarization will gather, piezo-electricity / electrostriction layer 102 changes to the condition of being shrunken from the condition of being extended horizontally.

[0023] Thus, it sets in the actuator section 100 in the indicating equipment concerning said example of a proposal. From the crookedness displacement property having a symmetry form in the forward direction and the negative direction of electric field focusing on a criteria electric-field point (electric field E= 0) The amount of relative displacements in electrical-potential-difference unloaded condition and an electrical-potential-difference impression condition and the amount of relative displacements in the condition of having applied the electric field of hard flow mutually are small, and there is a possibility that the control to the actuator section 100 may become difficult. Since this may become disadvantageous when aiming at improvement in image quality, it needs to take the cure immediately.

[0024] This invention is made in consideration of such a technical problem, and is added to the advantage of not making the number of pixels increase as compared with the case of monochrome screen, even if it is the case where it is made to apply to a color display method. When it has the advantage that the electrostatic capacity in the actuator section can be reduced and white is displayed all over the display screen, uniform display brightness can be obtained and it aims at offering the display which can aim at improvement in image quality.

[0025] [Means for Solving the Problem] The photoconductive corrugated plate into which, as for the display concerning this invention according to claim 1, light is introduced, The mechanical component by which it was countered and prepared in one plate surface of this photoconductive corrugated plate, and the actuator section of the number corresponding to many pixels was arranged is provided. By controlling displacement actuation of the contact / isolation direction of said actuator section to said photoconductive corrugated plate according to the attribute of the picture signal inputted, and controlling the leakage light of the predetermined part of said photoconductive corrugated plate In the display which displays the image according to said picture signal on said photoconductive corrugated plate The actuator section body which has the electrode of the pair formed in one principal plane of piezo-electricity / electrostriction layer, and this piezo-electricity / electrostriction layer as said actuator section, The oscillating section which supports said actuator section body in contact with the other principal planes of said piezo-electricity / electrostriction layer, The fixed part which supports said oscillating section possible [vibration] is made to provide, and the displacement transfer section which transmits displacement actuation of said actuator section produced by electrical-potential-difference impression to the electrode of said pair to a photoconductive corrugated plate is prepared and constituted.

[0026] Thereby, total reflection of the light introduced from the edge of a photoconductive corrugated plate is first carried out inside by adjusting the magnitude of the refractive index of a photoconductive corrugated plate, without all light penetrating in the front face and tooth back of a photoconductive corrugated plate. In this condition, if the displacement transfer section contacts the tooth back of a photoconductive corrugated plate in the distance below the wavelength of light, the light which was carrying out total reflection till then will be penetrated to the front face of the displacement transfer section in contact with the tooth back of a photoconductive corrugated plate. Although the light which arrived at the front face of the displacement transfer section is once reflected on the front face of a displacement transfer plate and a part is again reflected in a photoconductive corrugated plate as the scattered light, the great portion of scattered light will penetrate the front face of a photoconductive corrugated plate, without being reflected by the photoconductive corrugated plate.

[0027] Thus, the existence of luminescence (leakage light) of the light in the front face of a photoconductive corrugated plate is controllable by the existence of contact of the displacement transfer plate in the tooth back of a photoconductive corrugated plate. In this case, if one unit which makes the displacement actuation of the displacement transfer plate carry out in the contact / isolation direction to a photoconductive corrugated plate is considered as 1 pixel The images (an alphabetic character, graphic form, etc.) according to a picture signal can be displayed on the front face of a photoconductive corrugated plate like a cathode-ray tube or a liquid crystal display

by arranging a majority of this pixel in the shape of a matrix, and controlling the displacement actuation by each pixel according to the attribute of the picture signal inputted.

[0028] Next, the case where the display concerning this invention is applied to a color display method is explained. First, it is thought that recognition of human being's color is performed by mixing in three primary colors which remains on a vision nerve. That is, the same operation as the present color display method which performs mixing in three primary colors will be performed into human being's vision.

[0029] If this is got to know and the principle of coloring of this invention is explained, the principle of this coloring will be prescribed by the mixed method of R (red), G (green), and B (blue) which are the three primary colors of a color. Here, it considers trichotomizing the maximum luminescence time amount of RGB, using as T the period made to color. If the ratio of the luminescence time amount of RGB is 1:1:1, it will become the white light, and if the ratio of the luminescence time amount of RGB is 4:1:5, it will become the neutral colors according to the ratio. Therefore, control of the time amount made to color is synchronized with the period which makes the contact time of a photoconductive corrugated plate and a displacement transfer plate color, may control luminescence time amount in three primary colors, can be synchronized with the period which makes luminescence time amount in three primary colors color, and can also control the contact time of a photoconductive corrugated plate and a displacement transfer plate.

[0030] Since it is such, even if it is the case where it is made to apply to a color display method, in the display concerning this invention, there is an advantage of not making the number of pixels increase as compared with the case of monochrome screen.

[0031] Moreover, he is trying for the indicating equipment concerning this invention to have piezo-electricity / electrostriction layer, and the electrode of the pair formed in one principal plane of this piezo-electricity / electrostriction layer as a configuration of the actuator section body to which the variation rate of the displacement transfer section is carried out alternatively. In this case, if a predetermined electrical potential difference is impressed to the electrode of a pair, in one principal plane of piezo-electricity / electrostriction layer, electric field will arise in the direction of a field. In addition, this field strength has one largest principal plane (front face) of piezo-electricity / electrostriction layer, and becomes small gradually in the depth direction.

[0032] Although piezo-electricity / electrostriction layer produces elongation according to the electric field generated in the direction of a field of the one principal plane, since elongation is not produced in the oscillating section which, in addition to this, supports piezo-electricity / electrostriction layer in a principal plane, a difference arises in distortion in one principal plane and other principal planes of piezo-electricity / electrostriction layer, consequently the elastic deformation which made the 1 principal-plane side the convex produces piezo-electricity / electrostriction layer. The displacement transfer section displaces to a photoconductive corrugated plate side by the convex elastic deformation of this piezo-electricity / electrostriction layer, and induction of the generating of the leakage light from a photoconductive corrugated plate which was mentioned above is carried out.

[0033] In the display concerning this invention, since the electrode of a pair will be formed in the 1 principal-plane side of piezo-electricity / electrostriction layer and it will be placed between inter-electrode [of a pair] by the component (a dielectric constant is very small as compared with piezo-electricity / electrostriction layer) of air or the displacement transfer section, the electrostatic capacity of an actuator section body becomes small, and CR time constant on signal transduction also becomes small in connection with it. That is, it is hard coming to generate a provincial accent in the signal wave form of a voltage signal according to the attribute of a picture signal.

[0034] This is enabled to impress specified voltage to the electrode of the pair in each pixel alternatively, elongation required for each piezo-electricity / electrostriction layer can be given, and it is also controlled in the parts (for example, a screen periphery, a center section, etc.) corresponding to the actuator section especially allotted to the location distant from a part for a voltage signal feed zone that display brightness becomes weak.

[0035] Thus, even if it is the case where it is made to apply to a color display method, in the display concerning this invention, when it has the advantage that the electrostatic capacity in the actuator section can be reduced in addition to the advantage of not making the number of pixels increase as compared with the case of monochrome screen and white is displayed all over the display screen, uniform display brightness can be obtained and improvement in image quality can be aimed at.

[0036] Moreover, while being able to lose futility, such as whole surface remaking, in the middle of a production process, for example in a manufacture process only by repairing the electrode which disappeared even if it did not repair piezo-electricity / electrostriction layer since it fully functions as the actuator section when a part of piezo-electricity / electrostriction layer disappear with some electrodes on it by dielectric breakdown etc., improvement in the yield of a display can be made to attain.

[0037] In the display concerning above-mentioned this invention, if said oscillating section and said fixed part are formed in one with the ceramics, dead air space is formed in the part corresponding to said oscillating section and it is made for this oscillating section to serve as thin meat (invention according to claim 2), it will become possible to produce a fixed part and the oscillating section easily, and will become advantageous, when attaining cheap-ization

of the manufacturing cost of a display.

[0038] Moreover, since it becomes the form where a heavy-gage fixed part and the oscillating section of thin meat are formed by establishing dead air space in the base which consists of ceramics, the oscillating section can react on the elongation of piezo-electricity / electrostriction layer sensitively, and can be made into the high oscillating section of flattery nature to change of a voltage signal. Moreover, since the rigidity of the boundary part of the oscillating section and a fixed part is fully secured, it is hard coming to generate the destruction by the fatigue of the above-mentioned boundary part accompanying vibration of the oscillating section.

[0039] In the display concerning above-mentioned this invention, it considers as the configuration where the angle was able to take each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer, and is better than that of piezo-electricity / electrostriction layer as for a size in the magnitude of the flat-surface configuration of said dead air space (invention according to claim 3). In this case, since the boundary part of the oscillating section and a fixed part serves as the flat-surface configuration of dead air space, and the configuration where the angle was able to be taken similarly, it can be lost that the stress generated by vibration of the oscillating section concentrates locally, the fatigue limit in said boundary part can be raised, and reinforcement of the actuator section, as a result reinforcement of a display can be realized.

[0040] Each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer are good also as circular, and good also as [both] an ellipse configuration (invention according to claim 5). (invention according to claim 4) Moreover, each flat-surface configurations of both of said dead air space, and said piezo-electricity / electrostriction layer are good also as a configuration where it is a rectangle-like and the corner section was able to take the angle, and good also as a configuration where have the shape of both polygon (invention according to claim 6), and each vertical-angle part was roundish (invention according to claim 7).

[0041] In this case, all the peripheries of the oscillating section will be supported by the fixed part, the fatigue limit in the periphery part of the oscillating section can improve sharply, and reinforcement of the actuator section, as a result reinforcement of a display can be realized more.

[0042] In the display concerning above-mentioned this invention, it is good also as a configuration in which the electrode of a pair was estranged mutually in parallel and was mutually wired by the curled form in the flat-surface configuration on said piezo-electricity / electrostriction layer in the electrode of said pair (invention according to claim 8). In this case, if a predetermined electrical potential difference is impressed to the electrode of a pair, in one principal plane of piezo-electricity / electrostriction layer, electric field will arise at a radial (isotropic), therefore elongation will produce piezo-electricity / electrostriction layer in a radial (isotropic) in one principal plane. At this time, in a part with deep piezo-electricity / electrostriction layer, thereby, elongation smaller than the elongation of a surface part arises in a radial (isotropic), or shrinkage arises in a radial (isotropic), and piezo-electricity / electrostriction layer is displaced so that that core may serve as a convex efficiently, and moreover, its dispersion on displacement between each pixel also decreases.

[0043] In the display concerning above-mentioned this invention, it is good also as a configuration which it has the configuration which branched the flat-surface configuration on said piezo-electricity / electrostriction layer in the electrode of said pair from the management both prolonged toward the core on said piezo-electricity / electrostriction layer, and the electrode of said pair was estranged mutually, and was arranged by the complementary (invention according to claim 9). In this case, like said invention according to claim 8, when a predetermined electrical potential difference is impressed to the electrode of a pair, in one principal plane, elongation produces piezo-electricity / electrostriction layer in a radial (isotropic). At this time, in a part with deep piezo-electricity / electrostriction layer, it displaces so that that core may serve as a convex from elongation smaller than the elongation of a surface part arising in a radial (isotropic), or shrinkage arising in a radial (isotropic) efficiently, and dispersion on displacement between each pixel also decreases.

[0044] As long as the effect which it has on others is very small and management remains even if the piezo-electricity / electrostriction layer corresponding to a part of piezo-electricity / electrostriction layer, for example, a branch, disappear with this branch by dielectric breakdown etc. since especially invention according to claim 9 is divided into management and a branch, it will function enough as the actuator section. Of course, only by repairing the branch of said electrode which disappeared, it can return to the function before disappearance and simplification of maintenance to a display can be realized.

[0045] Spontaneous distortion is removed and you may make it drive said actuator section in the display concerning above-mentioned this invention by impressing the signal which makes inter-electrode [of said pair] reverse the direction of polarization of said piezo-electricity / electrostriction layer (invention according to claim 10). That is, whenever it gives a voltage signal to inter-electrode [of the pair of an actuator section body], the signal (for example, alternation signal of +100V ->-100V ->+100V ->-100V) which reverses the direction of polarization of piezo-electricity / electrostriction layer is impressed, and the actuator section is driven. In this case, the amount of displacement in the actuator section is always highly maintainable. This is because a variation rate is obtained in the form which always added the amount of displacement for spontaneous distortion of piezo-electricity /

electrostriction layer. It becomes advantageous, when the ON/OFF control in a display becomes easy and improvement in image quality is aimed at by considering as such a condition. In addition, even if it performs the above-mentioned drive, the amount of displacement does not become large with the structure piezo-electricity / whose electrostriction layer was pinched with the up electrode and the lower electrode, i.e., sandwich structure. [0046] crookedness of said actuator section according [on the indicating equipment concerning above-mentioned this invention, and] to the impression electric field of 4 times or more of the inter-electrode predetermined electric field of said pair -- a variation rate -- you may constitute so that a property may become unsymmetrical focusing on a criteria electric-field point (invention according to claim 11).

[0047] Said crookedness displacement property so that the electric field added to the actuator section may change in alternation, after impressing the electrical potential difference for polarization to inter-electrode [of the pair in an actuator section body] and carrying out polarization processing of piezo-electricity / the electrostriction layer crookedness of the actuator section when changing continuously the electrical potential difference impressed to inter-electrode [of a pair] -- a variation rate -- seeing -- the crookedness in this case -- with a variation rate The case where the case where the actuator section displaces to convex to an one direction (direction which the electrode of the pair formed on piezo-electricity / electrostriction layer faces free space) is displaced to the forward direction and a concave is made into the negative direction. Here, said predetermined electric field mean the electric field which the sense of polarization of the part near one principal plane (front face) of piezo-electricity / electrostriction layer reverses by impression of field reversing.

[0048] If a predetermined electrical potential difference is specifically applied to inter-electrode [of a pair] for example, in the forward direction in order to carry out polarization processing of piezo-electricity / the electrostriction layer, in one principal plane of piezo-electricity / electrostriction layer, the electric field of the forward direction will arise in the direction of a field. Said one principal plane of the field strength generated in piezo-electricity / electrostriction layer is the largest, and it becomes small gradually in the depth direction. Polarization processing of piezo-electricity / the electrostriction layer is carried out by generating of the electric field of said forward direction in the same direction as this electric field. Then, inter-electrode electrical-potential-difference impression of a pair is stopped, for example, and it considers as electrical-potential-difference unloaded condition.

[0049] And the electrical potential difference impressed to inter-electrode [of a pair] is continuously changed so that the electric field added to the actuator section may change in alternation. In the phase which electric field have produced in the same direction as the direction (for example, the forward direction) of the electric field produced at this time, at for example, the time of polarization processing, the direction of polarization in piezo-electricity / electrostriction layer and the direction of electric field will be in agreement, near the front face of piezo-electricity / electrostriction layer, electric field will be strong and piezo-electricity / electrostriction layer will be horizontally extended from this thing. To displace piezo-electricity / electrostriction component body in the direction of either an one direction and the other directions is considered by this.

[0050] Then, the electrical potential difference impressed to inter-electrode [of a pair] will change, and the following operations will be performed in the phase which the electric field of a direction contrary to the direction of the electric field at the time of polarization processing have generated in the actuator section.

[0051] First, the direction of polarization of piezo-electricity / electrostriction layer and the direction of electric field are reverse mutually, and piezo-electricity / electrostriction layer will be horizontally shrunken in the phase where electric field are weak. By this, the actuator section carries out crookedness displacement in the other directions. Then, if electric field become strong, polarization of the surface parts of piezo-electricity / electrostriction layer begins to be reversed, near the front face of piezo-electricity / electrostriction layer, the direction of polarization and the direction of electric field will be in agreement, and the phenomenon in which the direction of polarization and the direction of electric field become reverse will arise in a part with deep piezo-electricity / electrostriction layer. That is, in piezo-electricity / electrostriction layer, two kinds of polarization will exist and it will function as the piezo-electricity / an electrostriction component of a false bimorph mold.

[0052] Consequently, the direction of distortion in the part near one principal plane of piezo-electricity / electrostriction layer and the part near the oscillating section becomes reverse mutually, as a whole, convex displacement is carried out and the amount of displacement will become very large according to said false bimorph-operation in an one direction (direction which the electrode of the pair formed on piezo-electricity / electrostriction layer faces free space).

[0053] Especially, in this invention, a difference arises from the displacement property serving as an unsymmetrical form in the forward direction and the negative direction of electric field focusing on a criteria electric-field point in each amount of crookedness displacement in two peak value of the electric field which change periodically, for example. Thereby, the amount of relative displacements in electrical-potential-difference unloaded condition and an electrical-potential-difference impression condition and the amount of relative displacements in the condition of having applied the electric field of hard flow mutually become large. Therefore, when it considers as the actuator

section arranged per pixel of an indicating equipment, the control to these actuator section becomes easy, and it becomes very advantageous when aiming at improvement in the image quality in an indicating equipment. [0054] and the crookedness when impressing the electric field of 4 times or more of two predetermined electric fields from which an absolute value is the same as that of, and a direction differs on the basis of said criteria electric-field point in said configuration, respectively -- a variation rate -- when an amount is set to A and B, it is desirable to have the relation of $A >= 1.5B$ (invention according to claim 12). With this relation, the property which becomes unsymmetrical focusing on a criteria electric-field point as a crookedness displacement property can be acquired.

[0055] Moreover, in said configuration, the actuator section which should be considered as ON selection among the mechanical components of said large number is received about the predetermined electrical-potential-difference range impressed to the electrode of said pair. As opposed to the actuator section which the amount of displacement of the one direction in said crookedness displacement property should impress an electrical potential difference in the direction which is max (invention according to claim 13), and should presuppose OFF selection or un-choosing You may make it impress an electrical potential difference in the direction whose amount of displacement of the one direction in said crookedness displacement property is min (invention according to claim 14 or 15). the actuator section in which the maximum displacement was carried out and OFF selection or un-choosing the actuator section by which ON selection was made were presupposed by this in the one direction -- min -- the actuator section by which was made into the variation rate and OFF selection (or un-choosing) was made to the actuator section by which ON selection was made -- setting -- a variation rate -- the upper difference becomes clear and it becomes that it is possible to make clear the contrast and the profile of the image displayed on the display screen.

[0056] Moreover, in said configuration, when thickness of x (1 micrometer $\leq x \leq 200$ micrometer), and said piezo-electricity / electrostriction layer is set to y (1 micrometer $\leq y \leq 100$ micrometer) for an inter-electrode distance of said pair, it has the relation of $y = ax$ and you may constitute as $1 / 10 \leq a \leq 100$ (invention according to claim 16).

[0057] in this case, crookedness of said actuator section by the inter-electrode impression electric field of said pair -- a variation rate -- crookedness as a property shows to invention according to claim 11 -- a variation rate -- a property, i.e., the property which becomes unsymmetrical focusing on a criteria electric-field point, can be acquired. Therefore, also in the display concerning this this invention according to claim 16, the control to the actuator section arranged per pixel becomes easy like said display according to claim 11, and when aiming at improvement in the image quality in a display, it becomes very advantageous.

[0058] In said configuration, if it is $1 / 2 \leq a \leq 5$ to be referred to as $1 / 5 \leq a \leq 10$ preferably (invention according to claim 17) and it is $1 \text{ micrometer} \leq x \leq 60 \text{ micrometer}$ and $1 \text{ micrometer} \leq y \leq 40 \text{ micrometer}$, it is still more desirable (invention according to claim 18).

[0059] moreover, the time of setting thickness of the oscillating section to z ($1 \text{ micrometer} \leq z \leq 50 \text{ micrometer}$) in said configuration, when thickness y of said piezo-electricity / electrostriction layer and the thickness of said oscillating section are specified -- the relation of $y = bz$ -- having -- and $1 / 5 \leq b \leq 10$, then (invention according to claim 19) crookedness -- a variation rate -- it becomes possible to increase an amount.

[0060] In said configuration, if it is $1 / 3 \leq b \leq 5$ to be referred to as $1 / 3 \leq b \leq 5$ preferably (invention according to claim 20) and it is $1 \text{ micrometer} \leq y \leq 40 \text{ micrometer}$ and $1 \text{ micrometer} \leq z \leq 20 \text{ micrometer}$, it is still more desirable (invention according to claim 21).

[0061] Furthermore , in invention according to claim 10 to 21 , if the cross section configuration in the shortest dimension passing through the core of said oscillating section constitute so that it may be satisfied with electrical potential difference unloaded condition of the following conditions (invention according to claim 22) , since the amount of relative displacements of the actuator section in electrical potential difference unloaded condition and an electrical potential difference impression condition can be enlarge , the ON/OFF control in a display become easy and it become advantageous , when aim at improvement in image quality . and the produced actuator section -- receiving -- surely -- the big crookedness to an one direction -- a variation rate can be made to be able to perform and improvement in the yield of a display can be made to attain

[0062] (1) From the datum line which while approaches said fixed part and is constituted by connecting the outermost minimum point and the outermost minimum point of another side, a part of top face [at least] in near the center section of said the piezo-electricity / electrostriction layer has projected to said oscillating section and opposite direction.

[0063] (2) When said outermost minimum point does not exist, make the point corresponding to the boundary point with said fixed part into the outermost minimum point among the top faces of the oscillating section which meet said shortest dimension.

[0064] (3) When a boundary part with said fixed part of said oscillating section is made into zero point, the shortest dimension length of said oscillating section is set to 100 and said outermost minimum point cannot be found in 40% of range of the shortest dimension length in said oscillating section from said zero point, make the point corresponding to the boundary point with said fixed part into the outermost minimum point among the top faces of

the oscillating section which meet said shortest dimension.

[0065] It is still more desirable if said amount t of protrusions is especially set to $m/1000 \leq t \leq m/10$ in invention according to claim 22 (invention according to claim 23).

[0066]

[Embodiment of the Invention] Hereafter, the example of a gestalt of operation of the display concerning this invention (it is hereafter described as the display only applied to the gestalt of operation) is explained, referring to drawing 1 - drawing 29.

[0067] As shown in drawing 1, the display concerning the gestalt of this operation has the mechanical component 16 by which it was countered and prepared in the tooth back of the photoconductive corrugated plate 12 into which light 10 is introduced, and this photoconductive corrugated plate 12, and much actuator sections 14 were arranged corresponding to the pixel, and is constituted.

[0068] A mechanical component 16 has the base 18 which consisted of ceramics, and the actuator section 14 is arranged in the location according to each pixel of this base 18. The above-mentioned base 18 is arranged so that one principal plane may counter the tooth back of the photoconductive corrugated plate 12, and this one principal plane is made into the continuous field (flat-tapped). The dead air space 20 for forming in the location corresponding to each pixel the oscillating section mentioned later, respectively is established in the interior of a base 18. Each dead air space 20 is opened for free passage with the exterior through small through tube 18a of the path prepared in the other end side of a base 18.

[0069] The part in which dead air space 20 is formed among the above-mentioned bases 18 is used as thin meat, and is made heavy-gage [the other part]. The part of thin meat serves as the structure of being easy to receive vibration to external force, functions as the oscillating section 22, and functions as a fixed part 24 which supports the above-mentioned oscillating section 22, being used as parts other than dead-air-space 20 being heavy-gage.

[0070] That is, a base 18 is a layered product of sheet metal layer 18C which is substrate layer 18A which is the lowest layer, spacer layer 18B which is an interlayer, and the maximum upper layer, and can be grasped as an integral-construction object with which dead air space 20 was formed in the part corresponding to a pixel among spacer layer 18B. Substrate layer 18A functions as a substrate for reinforcement, and also functions as a substrate for wiring. In addition, the above-mentioned base 18 may really be baking, or may be post-installation.

[0071] The piezo-electricity / electrostriction layer 26 directly formed on this oscillating section 22 besides the above-mentioned oscillating section 22 and a fixed part 24 so that each actuator section 14 might be illustrated, As it is indicated in drawing 1 as the actuator section body 30 which has the electrode 28 (electrode 28a [one] and electrode 28b of another side) of the pair formed in the top face of this piezo-electricity / electrostriction layer 26 It has the displacement transfer section 32 which is connected on this actuator section body 30, and enlarges a touch area with the photoconductive corrugated plate 12, and is made into the area according to a pixel, and is constituted.

[0072] That is, the indicating equipment concerning the gestalt of this operation has the structure in which the actuator section body 30 which consists of piezo-electricity / an electrostriction layer 26, and an electrode 28 of a pair was formed on the base 18. Although the structure formed up and down to piezo-electricity / electrostriction layer 26 and the structure formed only in one side are sufficient as the electrode 28 of a pair, in order to make advantageous junction nature of a base 18, and the piezo-electricity / electrostriction layer 26 It is more desirable to form the electrode 28 of a pair only in the upper part (for a base 18 to be the opposite side) of piezo-electricity / electrostriction layer 26 so that a base 18, and the piezo-electricity / electrostriction layer 26 may touch directly in the condition that there is no level difference, like the display concerning the gestalt of this operation.

[0073] Here, it explains, referring to drawing 2 - drawing 9 about the configuration of each part material. First, as shown in drawing 2, the peripheral surface configuration of the dead air space 20 formed in a base 18 (refer to drawing 1), i.e., the flat-surface configuration of the oscillating section 22, is made into a circle configuration (refer to broken line), and the periphery configuration (refer to continuous line) formed by the flat-surface configuration (refer to alternate long and short dash line) list of piezo-electricity / electrostriction layer 26 with the electrode 28 of a pair is also made into the circle configuration. In this case, the magnitude of the oscillating section 22 is the largest, subsequently it considers as the periphery configuration of the electrode 28 of a pair, and the flat-surface configuration of piezo-electricity / electrostriction layer 26 is set up smallest. In addition, you may set up so that the periphery configuration of the electrodes 28a and 28b of a pair may become the largest.

[0074] The flat-surface configuration of the electrode 28 (electrode 28a [one] and electrode 28b of another side) of the pair formed on piezo-electricity / electrostriction layer 26 is made into the curled form of the number turn by which the electrodes 28a and 28b of these pairs were estranged mutually as shown in drawing 3. In practice, although it is 5 or more *****'s, the number of turns of this whorl is indicated as three turns in the example of drawing 3 , in order to avoid complication of a drawing.

[0075] And as wiring which leads to each electrodes 28a and 28b is shown in drawing 2 , it has the perpendicular selection line 40 of the number according to the line count of many pixels, and the signal line 42 of a number

according to the number of trains of many pixels. It connects with electrode 28a electrically, and each signal line 42 is electrically connected [in / in each perpendicular selection line 40 / each pixel (actuator section 14: refer to drawing 1)] to electrode 28b of another side of each pixel 14. Moreover, each above-mentioned perpendicular selection line 40 serves as the form about the pixel of the front row where about the pixel 14 concerned while was drawn from electrode 28a, connected with electrode 28a, and while was wired by series about one line. A signal line 42 consists of branch line 42b which branches from main track 42a and this main track 42a which are prolonged in the direction of a train, and is connected to electrode 28b of another side of each pixel 14.

[0076] Supply of the voltage signal to each perpendicular selection line 40 is performed through a through hole 44 from the wiring substrate (stuck on the other principal planes of a base 18) which is not illustrated, and is performed through a through hole 46 from the above-mentioned wiring substrate which does not illustrate supply of the voltage signal to each signal line 42, either.

[0077] Although various things can be considered as an arrangement pattern of through holes 44 and 46 In the example of drawing 2 , the through hole 44 of the perpendicular selection line 40 When a line count is set to M and the number of trains is set to N, in $N=M$ or $N>M$, it sets. Are near the pixel of a n line n train (1 n= two ...), and (n-1) it is formed in the location of the signal-line (main track 42a) approach of a train, and, in $N<M$, sets. ($\alpha N+n$) It is near the pixel of a line n train (0 $\alpha=$ one ... (quotient -1 of M/N)), and (n-1) is formed in the location of the signal-line (main track 42a) approach of a train.

[0078] On the other hand, in $N=M$ or $N<M$, the through hole 46 of a signal line 42 is set. Are on main track 42a of each signal line 42, and it is formed in the location close to the pixel of a n line n train (1 n= two ...), and, in $N>M$, sets. It is on main track 42a of each signal line 42, and is formed in the location close to the pixel of a n line ($\beta M+n$) train (0 $\beta=$ one ... (quotient -1 of N/M)). moreover, the junction for aiming at those electric flows among one [a through hole 44 and] electrode 28a, since the through hole 44 of the perpendicular selection line 40 is not formed on the perpendicular selection line 40 unlike the case of a signal line 42 -- a conductor 48 is formed.

[0079] In addition, it is placed between the parts which each perpendicular selection line 40 and each signal line 42 intersect by the insulator layer 50 (a two-dot chain line shows) which consists of silicon oxide, glass membrane, resin film, etc. in order to take the insulation between the mutual wiring 40 and 42.

[0080] It is good also as a configuration as shown in drawing 4 else [which is shown in drawing 3 / spiral] as a flat-surface configuration of the electrode 28 of a top Norikazu pair (display concerning the 1st modification). The display concerning this 1st modification specifically The electrodes 28a and 28b of a pair both possess the configuration which has the management 52 and 54 prolonged toward the core on above-mentioned piezo-electricity / electrostriction layer 26, and the branches 56 and 58 which come to branch from this management 52 and 54. And the electrodes 28a and 28b of a pair are made into the configuration (it is hereafter described as a multi-branch configuration for convenience) which was estranged mutually and arranged by the complementary.

[0081] Although the display concerning the display concerning the gestalt of the above-mentioned implementation and its 1st modification showed the case where the periphery configuration formed with the flat-surface configuration of the oscillating section 22, the flat-surface configuration of piezo-electricity / electrostriction layer 26, and the electrode 28 of a pair was made into a circle configuration In addition, as are shown in drawing 5 and drawing 6 and it is shown in an ellipse configuration (truck configuration: display concerning the 2nd and 3rd modifications), and drawing 7 , it is good also as elliptical (display concerning the 4th modification).

[0082] Moreover, as are shown in drawing 8 , and both the flat-surface configuration of the oscillating section 22 and the flat-surface configuration of piezo-electricity / electrostriction layer 26 are made into the shape of a rectangle and it is shown in the configuration (display concerning the 5th modification) where the corner section was able to take the angle, and drawing 9 It is good also as a configuration (display concerning the 6th modification) where made both the flat-surface configuration of the oscillating section 22, and the flat-surface configuration of piezo-electricity / electrostriction layer 26 into the shape of a polygon (the shape of for example, an octagon), and each vertical-angle part was roundish.

[0083] Moreover, the combination of a circle and an ellipse is sufficient as the configuration of the oscillating section 22, the flat-surface configuration of piezo-electricity / electrostriction layer 26, and the periphery configuration formed with the electrode 28 of a pair, and the combination of the shape of a rectangle and an ellipse is sufficient as it, and it is not limited especially. Moreover, as the flat-surface configuration of piezo-electricity / electrostriction layer 26 is shown in drawing 10 and drawing 11 , considering as the shape of a ring is also adopted preferably. As shown in drawing 13 A - 13C also in this case, various things, such as the shape of a circle, an ellipse, and a rectangle, are mentioned as a periphery configuration. The example which made the flat-surface configuration of piezo-electricity / electrostriction layer 26 in a circle at drawing 12 , and made the electrodes 28a and 28b of a pair the multi-branch configuration is shown.

[0084] Although the example of drawing 2 , drawing 8 , and drawing 9 showed the example which made arrangement of each actuator section 14 (pixel) on a base 18 the shape of a matrix, you may make it arrange a pixel (actuator section 14) alternately to each line like the indicating equipment concerning the 4th modification shown

by drawing 7. Since it becomes alternate in the case of the arrangement pattern of this drawing 7 arranging [of the actuator section 14 (pixel) about each line], Rhine (an alternate long and short dash line a shows) to which the perpendicular selection line 40 is connected, respectively is made into the shape of zigzag about each line. In the wiring substrate which is not illustrated, a signal line 42 has the pattern which two signal lines 42 were made to approach mutually the part corresponding to the pixel (actuator section 14) located in the perpendicular direction bottom among the pixels 14 allotted in the shape of [above-mentioned] alternate, and wired it, as shown in a broken line b. And electrode 28b of another side of a pixel (actuator section 14) located in the perpendicular direction bottom among the pixels allotted alternately on drawing 7 It connects electrically through a conductor 60 and a through hole 62. the above -- the signal line 42 of the right-hand side among two signal lines 42 and 42 which approach mutually, and junction -- electrode 28b of another side of a pixel (actuator section 14) located in the perpendicular direction bottom -- the above -- the signal line 42 of the left-hand side among two signal lines 42 and 42 which approach mutually, and junction -- it connects electrically through a conductor 64 and a through hole 66. [0085] Next, although explained referring to drawing 1, drawing 14 - drawing 26 about actuation of the display concerning the gestalt of the above-mentioned implementation, first, two examples of operation in each actuator section 14 are explained, and, subsequently actuation of the display itself is explained.

[0086] First, it explains, referring to drawing 1, drawing 14, and drawing 15 about the 1st example of the actuator section 14 of operation. In each pixel (actuator section 14) of the indicating equipment concerning the gestalt of this operation shown in drawing 1 When the voltage signal is not impressed to one electrode 28a of the actuator section 14, and electrode 28b of another side, in electrical-potential-difference unloaded condition Since an electrical potential difference (potential difference) is not produced between electrode 28a of a pair, and 28b, it is in the condition that did not produce elongation in piezo-electricity / electrostriction layer 26, but the displacement transfer section 32 and the photoconductive corrugated plate 12 were isolated.

[0087] Next, as shown in drawing 14, when a forward voltage signal is impressed to one electrode 28a of the actuator section 14, a negative voltage signal is impressed to electrode 28b of another side and between electrode 28a of a pair and 28b becomes a predetermined electrical potential difference, in the electrical-potential-difference impression condition, electric field E (refer to line-of-electric-force c) arise in the direction of a field in one principal plane of piezo-electricity / electrostriction layer 26. In addition, the strength of this electric field E has one largest principal plane (front face) of piezo-electricity / electrostriction layer 26, and it becomes small gradually in the depth direction.

[0088] Although it is in the above-mentioned electrical-potential-difference impression condition, and said piezo-electricity / electrostriction layer 26 will produce elongation according to the electric field E generated in the direction of a field of the one principal plane if the electrical potential difference which should be considered as ON selection between electrode 28a of a pair and 28b is impressed Since elongation is not produced in the oscillating section 22 which, in addition to this, supports piezo-electricity / electrostriction layer 26 in a principal plane, as a difference arises in distortion in one principal plane and other principal planes of piezo-electricity / electrostriction layer 26, consequently it is shown in drawing 1, the elastic deformation which made the 1 principal-plane side the convex produces piezo-electricity / electrostriction layer 26. By the convex elastic deformation of this piezo-electricity / electrostriction layer 26, the displacement transfer section 32 will carry out crookedness displacement at the photoconductive corrugated plate 12 side, and this displacement transfer section 32 will contact the photoconductive corrugated plate 12.

[0089] the above -- a variation rate -- the transfer section 32 -- crookedness of the actuator section body 30, although the tooth back of the photoconductive corrugated plate 12 is contacted corresponding to a variation rate If the displacement transfer section 32 contacts the tooth back of the photoconductive corrugated plate 12, the light 10 by which total reflection was carried out, for example within the photoconductive corrugated plate 12 will penetrate the tooth back of the photoconductive corrugated plate 12, will penetrate to the front face of the displacement transfer section 32, and will reflect on the front face of the displacement transfer section 32.

[0090] Thus, since the light 10 which penetrated the tooth back of the photoconductive corrugated plate 12 is reflected, the displacement transfer section 32 is formed in order to make a touch area with the photoconductive corrugated plate 12 larger than predetermined further. That is, luminescence area is prescribed by the touch area of the displacement transfer section 32 and the photoconductive corrugated plate 12.

[0091] and -- the display concerning the gestalt of this operation -- the above -- a variation rate -- a variation rate for the transfer section 32 to transmit the variation rate of plate member 32a which specifies a substantial luminescence area, and the actuator section body 30 to plate member 32a -- it has transfer member 32b.

[0092] In addition, the contact to the displacement transfer section 32 and the photoconductive corrugated plate 12 means that the displacement transfer section 32 and the photoconductive corrugated plate 12 are located in the distance below the wavelength of light 10 (light 10 introduced into the photoconductive corrugated plate 12).

[0093] Since it stops producing a predetermined electrical potential difference between electrode 28a of a pair, and 28b when having suspended supply of the voltage signal to one electrode 28a and electrode 28b of another side, for

example, un-choosing [OFF selection or], piezo-electricity / electrostriction layer 26 is restored to the original condition from the condition of the above-mentioned convex, and the displacement transfer section 32 and the photoconductive corrugated plate 12 will be in the condition of having been isolated.

[0094] Spontaneous distortion is removed and you may make it drive the above-mentioned actuator section 14 by impressing the signal which reverses the direction of polarization of said piezo-electricity / electrostriction layer 26 between electrode 28a of the pair of the actuator section body 30, and 28b at the time of actuation of the above-mentioned actuator section 14.

[0095] Whenever it gives a voltage signal between electrode 28a of the pair of the actuator section body 30, and 28b, in ON selection, the alternation signal of +100V ->-100V ->+100V ->-100V is impressed, and, specifically, it drives the actuator section 14 so that it may be shown in the signal which reverses the direction of polarization of piezo-electricity / electrostriction layer 26, for example, drawing 15. In this case, the amount of displacement in the actuator section 14 is always highly maintainable. This is because a variation rate is obtained in the form which always added the amount of displacement for spontaneous distortion of piezo-electricity / electrostriction layer 26. In addition, in OFF selection or not choosing, the electrical potential difference whose value with the small absolute value of electric field, for example, an absolute value, is less than [20V] should just be applied in alternation. The enhancement effect of said amount of displacement can be realized almost like the above, when the flat-surface configuration of piezo-electricity / electrostriction layer 26 is made into the shape of a ring (refer to drawing 10 - drawing 13). Since electrostatic capacity can be made still smaller by making piezo-electricity / electrostriction layer 26 into the shape of a ring especially, the effectiveness that the provincial accent of a driving signal etc. can be controlled effectively can be acquired.

[0096] Incidentally, even if it performs the above-mentioned drive, the amount of displacement does not become large with the structure piezo-electricity / whose electrostriction layer 26 was pinched with the up electrode and the lower electrode, i.e., the conventional sandwich structure.

[0097] Next, although explained referring to drawing 1, drawing 16 - drawing 25 about the 2nd example of the actuator section of operation, it explains, referring to drawing 1, drawing 16 - drawing 19 before that about the principle of operation of the actuator section 14 based on the 2nd example of operation.

[0098] first, crookedness of said actuator section 14 according to the impression electric field between electrode 28a of said pair, and 28b as the display concerning the gestalt of this operation is shown in drawing 16 B -- a variation rate -- a property becomes unsymmetrical focusing on a criteria electric-field point (point of electric field $E = 0$).

[0099] this crookedness -- a variation rate -- crookedness of the actuator section 14 when changing continuously the electrical potential difference applied to the actuator section 14, after a property's impressing a predetermined electrical potential difference between electrode 28a of the pair in the actuator section body 30, and 28b and carrying out polarization processing of piezo-electricity / the electrostriction layer 26 -- a variation rate is seen. As it is indicated in drawing 1 as the crookedness displacement in this case, the case where crookedness displacement of the case where the actuator section 14 carries out crookedness displacement convex to an one direction (direction which the electrodes 28a and 28b of the pair formed on piezo-electricity / electrostriction layer 26 face free space) is carried out at the forward direction and a concave is made into the negative direction.

[0100] An example is concretely given and explained about measurement of said crookedness displacement property. First, if a predetermined electrical potential difference is applied for example, in the forward direction between electrode 28a of a pair, and 28b in order to carry out polarization processing of piezo-electricity / the electrostriction layer 26 as shown in drawing 17 A for example, in one principal plane of piezo-electricity / electrostriction layer 26, the electric field (for example, electric field shown by +5E in drawing 16 B) of the forward direction will arise in the direction of a field. here -- 1 -- it is $E = \text{about } 2.5\text{kV/mm}$.

[0101] Said one principal plane of the field strength generated in piezo-electricity / electrostriction layer 26 is the largest, and it becomes small gradually in the depth direction. Therefore, although polarization of a deep part cannot advance easily, sufficient electric field, sufficient time amount, and moderate heat can be applied, and polarization can be advanced to the depth direction.

[0102] Polarization processing is carried out in the same direction as the added electric field by impressing the electric field (+5E) beyond the use range of the electric field used as the actuator section 14 of an indicating equipment (for example, setting to drawing 16 B +3 the range of $E - 3E$) to the bottom of moderate temperature for 7 hours.

[0103] Then, as shown in drawing 17 B, electrical-potential-difference impression of a between [electrode 28a of a pair and 28b] is stopped, and it considers as electrical-potential-difference unloaded condition. and measurement initiation -- the actuator section 14 -- the sine wave (refer to drawing 16 A) of the frequency of 1Hz, and peak value**3E -- impressing -- the variation rate in each point at that time (Point A - Point D) -- an amount is continuously measured with a laser displacement gage. It is the property Fig. of drawing 16 B which plotted the measurement result at that time in the electric-field-crookedness displacement graph. it is shown in the arrow head of drawing 16 B -- as -- crookedness -- the variation rate of a variation rate -- the amount is changing with the

continuous changes in electric field continuously with a certain amount of hysteresis.

[0104] Supposing it starts concretely from the point in time of electric-field +3E which shows measurement with Point A, it will set at Point A first. As shown in drawing 18 A, the direction of polarization in piezo-electricity / electrostriction layer 26 and the direction of electric field are in agreement. Near the front face of piezo-electricity / electrostriction layer 26, electric field will be strong and piezo-electricity / electrostriction layer 26 will be horizontally extended from this thing. The actuator section 14 About 0.8deltay carries out crookedness displacement in an one direction (direction which the electrodes 28a and 28b of the pair formed on piezo-electricity / electrostriction layer 26 face free space) (refer to drawing 16 B). In addition, 1deltay = it is about 1.6 micrometers.

[0105] Then, the electrical potential difference impressed between electrode 28a of a pair and 28b will change, and the following actuation will be performed in the phase which the electric field of a direction contrary to the direction of the electric field at the time of polarization processing have generated in the actuator section 14.

[0106] First, as shown in drawing 18 B, the direction of polarization of piezo-electricity / electrostriction layer 26 and the direction of electric field are reverse mutually, and piezo-electricity / electrostriction layer 26 will be horizontally shrunken in the phase of for example, the point B (- 0.6E) that electric field are weak. By this, the actuator section 14 is [about] to the other directions (direction which goes to the oscillating section 22 from piezo-electricity / electrostriction layer 26). -0.3deltay carries out crookedness displacement. Moreover, this phase is a phase which polarization in the surface parts of piezo-electricity / electrostriction layer 26 begins to reverse, therefore can define the electric field (- 0.6E) in this point B as predetermined electric field.

[0107] Then, if the electric field of the negative direction become strong, as shown in drawing 19 A, the polarization reversal in the surface parts of piezo-electricity / electrostriction layer 26 advances, near the front face of piezo-electricity / electrostriction layer 26, the direction of polarization and the direction of electric field will be in agreement, and the phenomenon in which the direction of polarization and the direction of electric field become reverse will arise in the deep parts of piezo-electricity / electrostriction layer 26. That is, in piezo-electricity / electrostriction layer 26, two kinds of polarization will exist and it will function as the actuator section 14 of a false bimorph mold. In the phase in which electric field became -3E especially, according to said false bimorph-operation, the amount of displacement of the actuator section 14 will become very large, and has become displacement = abbreviation 2.6deltay in the example of drawing 16 B.

[0108] Electric field move in the forward direction from negative. Next, electric field in the phase of for example, the weak point D (+0.6E) As shown in drawing 19 B, near the front face of piezo-electricity / electrostriction layer 26, the direction of polarization and the direction of electric field are reverse. In the deep parts of piezo-electricity / electrostriction layer 26, the direction of polarization and the direction of electric field are in agreement, near [electrostriction layer's / piezo-electricity // 26 / the] a front face shrinks horizontally, and it serves as the form where a deep part is extended horizontally. By this, the actuator section 14 is [about] to the other directions (direction which goes to the oscillating section 22 from piezo-electricity / electrostriction layer 26). -1.0deltay carries out crookedness displacement. Moreover, this phase is a phase which polarization in the surface parts of piezo-electricity / electrostriction layer 26 begins to reverse, therefore can define the electric field (+0.6E) in this point D as predetermined electric field like Point B.

[0109] And the polarization reversal near [in piezo-electricity / electrostriction layer 26] a front face will advance, and the direction of polarization of piezo-electricity / electrostriction layer 26 and the direction of electric field will be in agreement as the electric field to the forward direction become strong gradually. Therefore, the phase of tending toward Point A from Point D can also be called a repolarization processing phase.

[0110] As mentioned above, in order to evaluate whether said crookedness displacement property has symmetric property or it has asymmetry, it is necessary to measure by electric field larger enough than predetermined electric field (**0.6E). However, if it measures by slightly larger electric field than predetermined electric field, the case where the asymmetry which is the characteristic property of the actuator section 14 of the indicating equipment concerning the gestalt of this operation cannot be distinguished will arise.

[0111] then, crookedness -- a variation rate -- the electric field of 4 times or more of the electric field (here, it is defined as predetermined electric field) which the direction of polarization begins to reverse partially in order to distinguish the asymmetry of a property -- alternation ---like -- applying -- crookedness -- a variation rate -- it is desirable to evaluate a property. That is, if the amount of absolute displacement is enlarged and is measured, the asymmetry of a crookedness displacement property can be evaluated easily.

[0112] For example, what is necessary is to carry out the electric field of the forward direction to more than +2.0E, and just to measure in the display concerning the conventional example, by making the electric field of the negative direction below into -2.0E, since predetermined electric field are **0.5E. Moreover, what is necessary is to carry out the electric field of the forward direction to more than +2.4E, and just to measure in the display concerning the gestalt of this operation, by making the electric field of the negative direction below into -2.4E, since said predetermined electric field are **0.6E.

[0113] the electric field (**3E) larger enough in drawing 16 B than predetermined electric field (**0.6E) -- alternation --like -- applying -- crookedness -- a variation rate -- a variation rate [in / the property is measured and / in this case / the peak value (point A) of the electric field of the forward direction] -- a variation rate [in / in an amount ya / the peak value (point C) of the electric field of 0.8deltay and the negative direction] -- an amount yc is 2.6deltay and has relation of $yc=3.25ya$.

[0114] Next, the dimension relation for giving asymmetry to said crookedness displacement property is explained. First, when electrode 28a of said pair and thickness y of the distance x between 28b, and the piezo-electricity / electrostriction layer 26 are seen, it is made to fill the range of $1 / 10 \leq a \leq 100$, as are shown in drawing 20, and it is referred to as 1 micrometer $\leq x \leq 200$ micrometer and 1 micrometer $\leq y \leq 100$ micrometer and has the relation of $y=ax$. It is $1 / 5 \leq a \leq 10$ preferably about especially the proportionality constant a, and is $1 / 2 \leq a \leq 5$ still more preferably. In this case, if 1 micrometer $\leq x \leq 60$ micrometer and 1 micrometer $\leq y \leq 40$ micrometer are filled, in order that direction of polarization will be easily reversed to the depth with suitable piezo-electricity / electrostriction layer 26 and to raise the amount of displacement effectively in the case of electric-field impression of the direction of polarization, and hard flow, it becomes the optimal as the actuator section 14.

[0115] Here the distance x between electrode 28a of a pair, and 28b When the flat-surface configuration of the electrodes 28a and 28b of this pair is a curled form When one normal R1 is drawn from the method side periphery of outside in one electrode 28a as shown in drawing 21 A for example, the distance during the intersection Q2 of the origin Q1 of this normal R1, this normal R1, and the method side periphery of inside in electrode 28b of another side is pointed out.

[0116] Moreover, when the flat-surface configuration of the electrodes 28a and 28b of a pair is a multi-branch configuration and one normal R2 is drawn from the method side periphery of outside in the branch 56 of one electrode 28a as shown in drawing 21 B for example, the distance during the intersection Q4 of the origin Q3 of this normal R2, this normal R2, and the method side periphery of inside in the branch 58 of electrode 28b of another side is pointed out.

[0117] Next, when thickness y of piezo-electricity / electrostriction layer 26 and thickness z of the oscillating section 22 are seen, it is made to fill the range of $1 / 5 \leq b \leq 10$, as are shown in drawing 22, and it is referred to as 1 micrometer $\leq y \leq 100$ micrometer and 1 micrometer $\leq z \leq 50$ micrometer and has the relation of $y=bz$. It is $1 / 3 \leq b \leq 5$ preferably about especially the proportionality constant b. In this case, if 1 micrometer $\leq y \leq 40$ micrometer and 1 micrometer $\leq z \leq 20$ micrometer are filled, in order that direction of polarization will be easily reversed to the depth with suitable piezo-electricity / electrostriction layer 26 and to raise the amount of displacement effectively in the case of electric-field impression of the direction of polarization, and hard flow, it becomes the optimal as the actuator section 14.

[0118] Furthermore, in the display concerning the gestalt of this operation, irrespective of the 1st example of operation and the 2nd example of operation, as shown in drawing 23 and drawing 24, it is desirable that the cross-section configuration in the shortest dimension m passing through the core of said oscillating section 22 satisfies the following conditions. In addition, in drawing 23 and drawing 24, in order to avoid complication of a drawing, the publication of the electrodes 28a and 28b of a pair is omitted.

[0119] That is, as shown in drawing 23 B, it is that a part of top face [at least] in near the center section of said piezo-electricity / electrostriction layer 26 has projected to said oscillating section 22 and opposite direction by electrical potential difference unloaded condition (condition of electric field E= 0) from the datum line L which while approaches said fixed part 24 and is constituted by connecting the outermost minimum point P1 and the outermost minimum point P2 of another side.

[0120] Here with near the center section of piezo-electricity / the electrostriction layer 26 As shown in drawing 23 A, it sets in said shortest dimension m. The boundary part of the top face of a fixed part 24, and the top face of the oscillating section 22, respectively On the other hand, when it is defined as the boundary point K1 and the boundary point K2 of another side and said shortest dimension is set to 100, 40% of range a3 of central except 30% of range a2 is pointed out toward 30% of range a1, and the core of the boundary point K2 of said another side to the shortest dimension m toward the core of the shortest dimension m from one [said] boundary point K1.

[0121] As shown in drawing 23 B, moreover, with one [said] outermost minimum point P1 The inside of two or more minimum points formed in the projection line to one principal plane of said piezo-electricity / electrostriction layer 26, and said shortest dimension side of the top face of the oscillating section 22 in said shortest dimension m, Saying the minimum point which approaches one [said] boundary point K1 most, the outermost minimum point P2 of another side means the minimum point which approaches most the boundary point K2 of said another side among said two or more minimum points.

[0122] In this case, when said shortest dimension is set to 100, it is what exists toward the core of the shortest dimension m in 40% of range (one minimum point existence region b1) from one [said] boundary point K1. And it is that to which the minimum point which approaches one boundary point K1 most is authorized as one outermost minimum point P1, and exists toward the core of the shortest dimension m in 40% of range (the minimum point

existence region b2 of another side) from the boundary point K2 of said another side. And the minimum point which approaches the boundary point K2 of another side most is authorized as the outermost minimum point P2 of another side.

[0123] Said outermost minimum points P1 and P2 may exist more nearly up than the top face of a fixed part 24, as are shown in drawing 23 B, and shown in the case where it exists caudad rather than the top face of a fixed part 24, and drawing 18 C.

[0124] In addition, when the outermost minimum point P2 of another side does not exist in the minimum point existence region b2 of another side as shown in drawing 24 A for example, the boundary point K2 of said another side is authorized as the outermost minimum point P2 of another side. This is the same also at one outermost minimum point P1. Moreover, as shown in drawing 23 A and drawing 24 B, when the outermost minimum points P1 and P2 do not exist, respectively in both minimum point existence regions b1 and b2, one boundary point K1 and the boundary point K2 of another side are authorized as the outermost minimum point P1 which is one side, respectively, and the outermost minimum point P2 of another side.

[0125] And in said conditions, i.e., the conditions "a part of top face [at least] in near the center section of piezo-electricity / the electrostriction layer 26 should project in the oscillating section 22 and an opposite direction by electrical-potential-difference unloaded condition from the datum line L", when said shortest dimension length is set to m, it is more desirable that the amount t of protrusions fills $m/1000 \leq t \leq m/10$.

[0126] The surely big variation rate to an one direction can be made to be able to perform to the produced actuator section 14, and improvement in the yield at the time of using it for a display can be made to attain by fulfilling said conditions.

[0127] Next, the 2nd example of operation in the actuator section 14 is explained. First, apart from the drive, polarization processing (initial polarization processing) is performed to each pixel (actuator section 14) about the indicating equipment concerning the gestalt of this operation shown in drawing 1. This initial polarization processing is performed by impressing the electric field (+5E) beyond the use range of the electric field used as an actuator (for example, setting to drawing 16 B +3 the range of E - -3E) to the bottom of moderate temperature for 7 hours. Polarization processing of the piezo-electricity / the electrostriction layer 26 in each pixel is carried out in the same direction as the added electric field by this.

[0128] About all pixels, in the phase which initial polarization processing ended, electrical-potential-difference impression of a between [electrode 28a of a pair and 28b] is stopped, and it considers as electrical-potential-difference unloaded condition.

[0129] And in the drive to a display, an image is displayed by making three actuation (un-choosing [ON selection, OFF selection, and]) perform fundamentally to a pixel.

[0130] ON selection is performed in the predetermined selection period Ts by generating the electric field Ea (referring to drawing 16 B) of the negative direction between electrode 28a of a pair, and 28b by impressing an electrical potential difference Va to the electrodes 28a and 28b of the pair of a pixel, as shown in drawing 25 A. OFF selection is performed in the predetermined selection period Ts by generating the electric field Ed (referring to drawing 16 B) of the negative direction or the forward direction between electrode 28a of a pair, and 28b by impressing an electrical potential difference Vd to the electrodes 28a and 28b of the pair of a pixel, as shown in drawing 25 B.

[0131] Un-choosing is performed in periods other than a selection period Ts (the non-selection period Ta) by generating the electric field Ef of the forward direction, or Eg (referring to drawing 16 B) between electrode 28a of a pair, and 28b by impressing an electrical potential difference Vf or Vg to the electrodes 28a and 28b of the pair of a pixel, as shown in drawing 25 A or drawing 25 B. In this non-selection period Ta, since the electric field of the forward direction occur like initial polarization processing, processing (it is described as repolarization processing for convenience) in which the piezo-electricity / electrostriction layer 26 of the pixel made into the condition of not choosing applied to polarization processing correspondingly is performed.

[0132] If drive actuation of the display concerning the gestalt of this operation is explained concretely Although the pixel group of one line is chosen at a time like the 1st line and ... of 2nd line the n-th line for every 1 horizontal-scanning period according to potential supply on the perpendicular selection line 40 by the perpendicular shift circuit which consisted of shift registers based on the input of the picture signal to an indicating equipment As opposed to the signal line 42 about the pixel 14 which should carry out ON selection among the selected lines, potential supply is performed over the predetermined selection period Ts from the level shift circuit which consisted of shift registers. Consequently, predetermined potential negative to electrode 28a of one of these in the pixel 14 by which ON selection was made is impressed by a perpendicular shift circuit and the level shift circuit, electropositive potential is impressed to electrode 28b of another side, and the electrical potential difference between electrode 28a of a pair and 28b is made the predetermined electrical potential difference Va (refer to drawing 25 A) of the negative direction. At this time, as shown in drawing 16 B and drawing 19 A, between electrode 28a of a pair, and 28b, the electric field Ea (the electric field at the time of for example, initial polarization processing of -3E:or un-

choosing are the electric field of hard flow) of the negative direction occur, and the actuator section 14 in the pixel concerned is displaced to an one direction like about 2.6deltay.. This condition shows ON selection condition, when it sees with a display. In the state of this ON selection, according to convex deformation of the actuator section 14, the displacement transfer section 32 will displace to the photoconductive corrugated plate 12 side, and this displacement transfer section 32 will contact the photoconductive corrugated plate 12.

[0133] About the pixel which does not make ON selection among the pixel groups about the line chosen in the perpendicular shift circuit on the other hand, or the pixel 14 which made OFF selection It considers as the potential in which the potential of the signal line 42 about the pixel 14 concerned differs from the potential at the time of ON selection over the predetermined selection period Ts. Negative predetermined potential is impressed to one electrode 28a of the pixel 14 concerned, and negative or electropositive potential is impressed to electrode 28b of another side, and let the electrical potential difference between electrode 28a of a pair, and 28b be the predetermined electrical potential difference Vd (to refer to drawing 25 B) of the negative direction or the forward direction. At this time, the actuator section [in / as shown in drawing 16 B, between electrode 28a of a pair and 28b, the electric field Ed (for example, -0.6E - +0.6E) of the negative direction or the forward direction occur, and / the pixel concerned] 14 is [about]. -1.0deltay-0.5deltay is displaced to an one direction. This condition shows an OFF selection condition, when it sees with a display. In the state of this OFF selection, it will be in the condition that the displacement transfer section 32 estranged from the photoconductive corrugated plate 12 side, by said displacement actuation of the actuator section 14.

[0134] In the subsequent condition of not choosing, repolarization processing will be carried out and the actuator section 14 about the pixel by which ON selection or OFF selection was made will displace about 1deltay to an one direction (direction which the electrodes 28a and 28b of the pair formed on piezo-electricity / electrostriction layer 26 face free space). Although set to the voltage level Vg and Vf (refer to drawing 25 A and drawing 25 B) on which the electrical-potential-difference change based on other ON selections and OFF selections in a line has been superimposed in this condition do not choose, since existence of this superposition component (cross talk component) makes a certain amount of repolarization processing perform to the actuator section 14 in the condition do not choose, it is useful to the recovery of the amount of displacement and the recovery of the responsibility as a display to change of electric field. That is, said cross talk component will make recovery of responsibility serve a double purpose.

[0135] In addition, as a voltage level for performing OFF selection as a voltage level for performing ON selection that what is necessary is just the voltage level of the negative direction rather than a voltage level Vb (voltage level which is equivalent to electric field Eb (for example, -2E) in drawing 16 B), what is necessary is just the voltage level of either of the range of voltage-level Vc-Ve (voltage level which is equivalent to the range of electric fields Ec (for example, -0.6E)-Ee (+0.6E) in drawing 16 B). Moreover, as a voltage level for performing repolarization processing, what is necessary is just the voltage level of the forward direction from a voltage level Ve (voltage level which is equivalent to electric field Ee (for example, +0.6E) in drawing 16 B).

[0136] Next, actuation of the display concerning the gestalt of this operation is explained, referring to drawing 1. First, the light 10 of the photoconductive corrugated plate 12 is introduced from an edge. In this case, total reflection is carried out inside by adjusting the magnitude of the refractive index of the photoconductive corrugated plate 12, without all the light 10 penetrating in the front face and tooth back of the photoconductive corrugated plate 12. In this condition, if the displacement transfer section 32 corresponding to said actuator section 14 contacts the tooth back of the photoconductive corrugated plate 12 in the distance below the wavelength of light, a certain actuator section 14 being used as an electrical-potential-difference impression condition or ON selection condition, the light 10 which was carrying out total reflection till then will be penetrated to the front face of the displacement transfer section 32 in contact with the tooth back of the photoconductive corrugated plate 12. Although the light 10 which arrived at the front face of the displacement transfer section 32 is reflected on the front face of the displacement transfer section 32 and a part is again reflected in the photoconductive corrugated plate 12 as the scattered light 70, the great portion of scattered light 70 will once penetrate the front face of the photoconductive corrugated plate 12, without being reflected by the photoconductive corrugated plate 12.

[0137] That is, the existence of luminescence (leakage light) of the light in the front face of the photoconductive corrugated plate 12 is controllable by the existence of contact of the displacement transfer section 32 in the tooth back of the photoconductive corrugated plate 12. Especially in the display concerning the gestalt of this operation, one unit which makes the displacement actuation of the displacement transfer section 32 carry out in the contact / isolation direction to the photoconductive corrugated plate 12 is made into 1 pixel. Furthermore, since he is trying to arrange a majority of these pixels alternately about the shape of a matrix, and each line, By controlling the displacement actuation by each pixel according to the attribute of the picture signal inputted, the images (an alphabetic character, graphic form, etc.) according to a picture signal can be displayed on the front face of the photoconductive corrugated plate 12 like a cathode-ray tube or a liquid crystal display.

[0138] Next, the case where the display concerning the gestalt of this operation is applied to a color display method

is explained. First, the principle of coloring of the display concerning the gestalt of this operation is prescribed by the mixed method of R (red), G (green), and B (blue) which are the three primary colors of a color as well as the present color display method. The period made to color is set to T here, and if the ratio of the luminescence time amount of RGB is 4:1:5 as are shown in drawing 26 A, and it becomes the white light and is shown in drawing 26 B, if the ratio of the luminescence time amount of RGB is 1:1:1 when trichotomizing the maximum luminescence time amount of RGB is considered, it will become the neutral colors according to the ratio. Therefore, control of the time amount made to color is synchronized with the period T which makes the contact time of the photoconductive corrugated plate 12 and the displacement transfer section 32 color, may control luminescence time amount in three primary colors, can be synchronized with the period T which makes luminescence time amount in three primary colors color, and can also control the contact time of the photoconductive corrugated plate 12 and the displacement transfer section 32.

[0139] Even if it is the case where it is made to apply to a color display method in the display concerning the gestalt of this operation from such a thing, there is an advantage of not making the number of pixels increase as compared with the case of monochrome screen.

[0140] In addition, although it is made to perform repolarization processing to each pixel at a non-selection period with the gestalt of said the operation of this In addition, it sets at three periods, the period of the luminescence termination point in time of R to the luminescence initiation time of the following G, the period of the luminescence termination point in time of G to the luminescence initiation time of the following B, and the period of the luminescence termination point in time of B to the luminescence initiation time of the following R. For example, the same electric field as initial polarization processing are impressed, and it may be made to carry out repolarization processing. In this case, you may make it combine with the repolarization processing in said non-selection period.

[0141] As the light source of the illumination light which carries out incidence to the photoconductive corrugated plate 12, fluorescence tubing, light emitting diode, a laser beam, etc. are used preferably, for example. Moreover, you may use it combining a halogen lamp, a xenon lamp, and a color filter. A switch of RGB is realizable by using ON/OFF of a mechanical shutter or a switch.

[0142] The display concerning the gestalt of this operation is single, can be used, and also as shown in drawing 27, it can use the display concerning the gestalt of this operation as one display device 74 of a large screen display 72. The example of this drawing 27 shows the example which made the tooth back of the light guide plate 76 which has the screen product of a big screen arrange a display device 74 in seven pieces and 18 longitudinal directions to a lengthwise direction. In this case, when the light transmittance in light fields, such as a glass plate and an acrylic board, is size, a uniform thing is used and a light guide plate 76 is connected by wirebonding, soldering and an end-face connector, a rear-face connector, etc. between each display device 74, mutual signal supply can be performed.

[0143] Moreover, in the large screen display 72 shown in drawing 27, the display shown in drawing 7 as a display applied to each display device 74 is used, and what made the list of the pixel 32 pieces to 32 pieces and a perpendicular direction horizontally is used. Since the display shown in drawing 7 makes the list of the pixel about each line alternate, the horizontal array pitch of a pixel can be made very small, and horizontal and when the number of arrays of a vertical pixel is made the same, an overall flat-surface configuration turns into a longwise configuration.

[0144] Although the example which has arranged the display device 74 which contains the photoconductive corrugated plate 12 in the plate surface of the large-sized light guide plate 76 in the shape of a matrix was shown, the large-sized light guide plate 76 is omitted, and it is what has arranged the display device 74 containing the photoconductive corrugated plate 12 in the shape of a matrix, and you may make it constitute a large screen display 72 in the large screen display 72 shown in drawing 27. In this case, the photoconductive corrugated plate 12 of a large number allotted in the shape of a matrix will make said large-sized light guide plate 76 serve a double purpose. The display device 74 which does not contain the photoconductive corrugated plate 12 in the plate surface of the large-sized light guide plate 76 besides said configuration is arranged in the shape of a matrix, and you may make it constitute said large screen display 72.

[0145] Said light guide plate 76 and photoconductive corrugated plate 12 have that desirable to which the refractive index was similar, and when sticking a light guide plate 76 and the photoconductive corrugated plate 12, they may use transparent adhesives. These adhesives are desirable when also setting a refractive index as a light guide plate 76, the photoconductive corrugated plate 12, and a near thing preferably [it is uniform in a light field and / having high permeability] like the photoconductive corrugated plate 12 or a light guide plate 76 secures the brightness of a screen.

[0146] Next, selection of the ingredient of each configuration member of the above-mentioned actuator section 14, especially each configuration member etc. is explained.

[0147] First, as for the oscillating section 22, it is desirable that it is a high thermal-resistance ingredient. When making the reason into the structure of making the direct oscillating section 22 supporting by the fixed part 24,

without using the ingredient which is inferior to the thermal resistance of organic adhesives etc. in the actuator section 14, in order to make it the oscillating section 22 not deteriorate at least at the time of formation of piezoelectricity / electrostriction layer 26, as for the oscillating section 22, it is desirable that it is a high thermal-resistance ingredient.

[0148] Moreover, in order to perform electric separation with the signal line 42 which leads to electrode 28b of the perpendicular selection line 40 by which while leads to electrode 28a, and another side in the electrode 28 of the pair formed on a base 18, as for the oscillating section 22, it is desirable that it is an electrical insulation material.

[0149] Therefore, its ceramics is the optimal although the oscillating sections 22 may be ingredients, such as a hoe low which covered the metal of high thermal resistance, or its surface of metal with ceramic ingredients, such as glass.

[0150] As ceramics which constitutes the oscillating section 22, the zirconium dioxide stabilized, for example, an aluminum oxide, magnesium oxide, titanium oxide, a spinel, a mullite, alumimum nitride, silicon nitride, glass, such mixture, etc. can be used. The stable zirconium dioxide is especially desirable because of chemical reactivity with that a mechanical strength is high, that toughness is high, the piezo-electricity / electrostriction layer 26, and the electrode 28 of a pair being small etc., even if the thickness of the oscillating section 22 is thin. With the stable zirconium dioxide, a stabilization zirconium dioxide and a partial stabilization zirconium dioxide are included. In the stable zirconium dioxide, in order to take the crystal structures, such as a cubic, phase transition is not caused.

[0151] On the other hand, around 1000 degrees C, phase transition of the zirconium dioxide may be carried out by the monoclinic system and ******, and a crack may generate it at the time of this phase transition. the stable zirconium dioxide -- stabilizing agents, such as an oxide of a calcium oxide, magnesium oxide, an oxidization yttrium, scandium oxide, an oxidization ytterbium, cerium oxide, or a rare earth metal, -- 1-30-mol % -- it contains. In order to raise the mechanical strength of the oscillating section 22, it is desirable that a stabilizing agent contains yttrium oxide. this time -- yttrium oxide -- desirable -- 1.5-6-mol % -- containing -- further -- desirable -- 2-4-mol % -- it is containing and it is desirable that the further 0.1-5-mol % of aluminum oxide contains.

[0152] Moreover, although crystal phases may be the mixed phase of a cubic + monoclinic system, the mixed phase of a tetragonal + monoclinic system, a mixed phase of a cubic + tetragonal + monoclinic system, etc., what the main crystal phase made the mixed phase of a ***** or tetragonal + cubic is the most desirable [crystal phases] from a viewpoint of reinforcement, toughness, and endurance especially.

[0153] In order to raise the mechanical strength of the oscillating section 22 although much crystal grain constitutes the oscillating section 22 when the oscillating section 22 consists of ceramics, as for the mean particle diameter of crystal grain, it is desirable that it is 0.05-2 micrometers, and it is still more desirable that it is 0.1-1 micrometer.

[0154] Although consisting of ceramics is desirable as for a fixed part 24, the same ceramics as the ingredient of the oscillating section 22 is sufficient as it, and they may differ. As ceramics which constitutes a fixed part 24, the stable zirconium dioxide, an aluminum oxide, magnesium oxide, titanium oxide, a spinel, a mullite, alumimum nitride, silicon nitride, glass, such mixture, etc. can be used like the ingredient of the oscillating section 22.

[0155] The ingredient with which especially the base 18 used with the indicating equipment concerning the gestalt of this operation uses a zirconium dioxide as a principal component, the ingredient which uses an aluminum oxide as a principal component, or the ingredient which uses such mixture as a principal component is adopted suitably. Also in it, what used the zirconium dioxide as the principal component is still more desirable. In addition, although clay etc. may be added as sintering acid, it is necessary to adjust an assistant component so that what it is [boron oxide / oxidation silicon] easy to vitrify may not be contained superfluously. The ingredient which is [these-] easy to vitrify is because it becomes the cause by which promote the reaction of a base 18, and the piezo-electricity / electrostriction layer 26, and it becomes difficult to maintain the presentation of predetermined piezo-electricity / electrostriction layer 26, consequently a component property is reduced although it is advantageous when joining a base 18, and the piezo-electricity / electrostriction layer 26.

[0156] That is, as for the oxidation silicon in a base 18 etc., it is desirable to restrict still more preferably, 3% or less, by the weight ratio, so that it may become 1% or less. Here, a principal component means the component which exists at 50% or more of a rate by the weight ratio.

[0157] Although piezoelectric ceramics can be used suitably, even if you may be the electrostriction ceramics or the ferroelectric ceramics and it is the ingredient which still needs polarization processing as a component of piezo-electricity / electrostriction layer 26, you may be an ingredient without the need. Furthermore, you may be the piezo electric crystal which consists of a macromolecule which is not limited to the ceramics but is represented by PVDF (polyvinylidene fluoride) again, or the complex of these macromolecules and the ceramics.

[0158] As ceramics used for piezo-electricity / electrostriction layer 26, ceramics containing which [these] combination, such as lead zirconate, magnesium niobic acid lead, nickel niobic acid lead, zinc niobic acid lead, manganese niobic acid lead, magnesium tantalic acid lead, nickel tantalic acid lead, antimony stannic-acid lead, lead titanate, barium titanate, a magnesium lead wolframate, and cobalt niobic acid lead, is mentioned, for example. It cannot be overemphasized that these compounds may be the principal components which occupy 50 % of the

weight or more. Moreover, the operating frequency of the ceramics which contains lead zirconate among the above-mentioned ceramics is the highest as a component of the piezo-electricity / electrostriction layer 26 of the gestalt of this operation.

[0159] Moreover, when it constitutes piezo-electricity / electrostriction layer 26 from ceramics, the ceramics which added suitably oxides, such as a lanthanum, calcium, strontium, molybdenum, a tungsten, barium, niobium, zinc, nickel, and manganese, which [these] combination, or other compounds may be further used for the above-mentioned ceramics.

[0160] For example, it is desirable to use the ceramics which uses as a principal component the component which consists of magnesium niobic acid lead, lead zirconate, and lead titanate, and contains a lanthanum and strontium further.

[0161] Piezo-electricity / electrostriction layer 26 may be precise, or may be porosity, and, in the case of porosity, it is [the porosity] desirable that it is 40% or less.

[0162] And as for the thickness of the oscillating section 22 in the above-mentioned base 18, and the thickness of the piezo-electricity / electrostriction layer 26 formed on this oscillating section 22, it is desirable that it is the thickness of this dimension. Because, in order to work to the burning shrinkage of piezo-electricity / electrostriction layer 26 so that the oscillating section 22 may bar the contraction if the thickness of the oscillating section 22 becomes thicker than the thickness of piezo-electricity / electrostriction layer 26 extremely (when single or more figures differ), the stress in piezo-electricity / electrostriction layer 26, and base 18 interface becomes large, and it becomes easy to peel. If the dimension of thickness is comparable, since a base 18 (oscillating section 22) becomes easy to follow the burning shrinkage of piezo-electricity / electrostriction layer 26 on the contrary, it is suitable for unification. As for the thickness of the oscillating section 22, it is desirable that it is 1-100 micrometers, its 3-50 micrometers are still more desirable, and, specifically, its 5-20 micrometers are further in addition desirable. On the other hand, piezo-electricity / electrostriction layer 26 has desirable 5-100 micrometers as the thickness, its 5-50 micrometers are still more desirable, and its 5-30 micrometers are further in addition desirable.

[0163] Although the electrode 28 of the pair formed on above-mentioned piezo-electricity / electrostriction layer 26 is made into proper thickness according to an application, it is desirable that it is the thickness of 0.01-50 micrometers, and its 0.1-5 micrometers are still more desirable. Moreover, the electrode 28 of the above-mentioned pair is a solid-state at a room temperature, and it is desirable to consist of conductive metals. For example, the metal simple substance or alloy containing aluminum, titanium, chromium, iron, cobalt, nickel, copper, zinc, niobium, molybdenum, a ruthenium, a rhodium, silver, tin, a tantalum, a tungsten, iridium, platinum, gold, lead, etc. is mentioned. It cannot be overemphasized that these elements may be contained in the combination of arbitration.

[0164] As for displacement transfer member 32b of the displacement transfer section 32, what has the degree of hardness of extent which can transmit the variation rate of the actuator section 14 to the direct photoconductive corrugated plate 12 is desirable. Therefore, although rubber, organic resin, an organic adhesive film, glass, etc. are mentioned as a desirable thing as the quality of the material of the above-mentioned displacement transfer member 32b, you may be the quality of the material of the electrode layer itself, a piezo electric crystal, or the ceramics mentioned above. most -- desirable -- an epoxy system, acrylic, a silicone system, and poly -- philharmonic me -- a system -- etc. -- organic resin or an organic adhesive film is good. Furthermore, it is also effective to mix a filler with these and to control hardening contraction.

[0165] The ingredient which made organic resin, such as an epoxy system besides the ingredient of said displacement transfer member 32b, acrylic, and a silicone system, high-distribute the ceramic powder which has a high refractive index, for example, zirconia powder, titania powder, lead oxide powder, those mixed powder, etc. as the quality of the material of plate member 32a is desirable in respect of luminous efficiency and surface smoothness maintenance. In this case, resin weight: Ceramic powder weight =1: (0.1-10) is good. Furthermore, when glass powder with a mean particle diameter of 0.5-10 micrometers is added at a rate of 1: (0.1-1.0) to ceramic powder to said presentation, since contact nature with the field of the photoconductive corrugated plate 12 and a mold-release characteristic are improved, it is desirable.

[0166] In addition, said plate member 32a [0.5 micrometers or less] 1 micrometer or less is specifically [it is desirable that the display flatness of the part (field) in contact with the photoconductive corrugated plate 12 and smoothness make it sufficiently small as compared with the amount of displacement of the actuator section 14, and] 0.1 micrometers or less especially preferably still more preferably. however, a variation rate -- the display flatness of the part (field) in contact with the photoconductive corrugated plate 12 of the transfer section 32 -- a variation rate -- if the contact part concerned deforms in the condition of it having been important and having contacted in order that the transfer section 32 may reduce the clearance in the condition of having contacted the photoconductive corrugated plate 12, it will not necessarily be limited to the above-mentioned display flatness.

[0167] The connection with the actuator section body 30 of said displacement transfer section 32 In using the ingredient mentioned above as the displacement transfer section 32 The solution of the ingredient which carried out the laminating of the displacement transfer section 32 of the ingredient mentioned above using adhesives, or was

mentioned above, What is necessary is just to carry out by forming by the approach of coating a paste thru/or a slurry on the upper part of the actuator section body 30, the photoconductive corrugated plate 12, or a light guide plate 76 (referring to drawing 27).

[0168] What is necessary is just to consider as the ingredient which serves as the ingredient of displacement transfer member 32b as adhesives preferably, when connecting said displacement transfer section 32 to the actuator section body 30. If an organic adhesive film is used especially, since it can use as adhesives by applying heat, it is desirable.

[0169] The photoconductive corrugated plate 12 has an optical refractive index which carries out total reflection, without the light 10 introduced into the interior penetrating to the exterior of the photoconductive corrugated plate 12 in a front face and a tooth back, and needs for the permeability in a light wavelength field to be high uniformly. Although especially the quality of the material will not be restricted if such a property is provided, specifically, translucency plastics, such as glass, a quartz, and an acrylic, translucent ceramics, etc. are mentioned as what has the general thing which prepared the coating layer in two or more layer structure of an ingredient which has a different refractive index, or a front face.

[0170] Next, the manufacture approach of the display concerning the gestalt of this operation is explained. The base 18 containing the oscillating section 22 and a fixed part 24 can be unified by carrying out the laminating of the shaping layer which is a green sheet or a green tape, and subsequently calcinating it by thermocompression bonding etc. For example, what is necessary is just to prepare beforehand the window part of the predetermined configuration which serves as dead air space 20 at the 2nd layer in front of the laminating in the base 18 of drawing 1, although the laminating of a two-layer green sheet or a two-layer green tape is carried out. Moreover, a shaping layer may be produced with the pressing and the slip casting using a die, injection molding, etc., and the window part used as dead air space 20 etc. may be prepared by machining of punching by cutting, the grinding process, laser beam machining, and press working of sheet metal etc. In drawing 1, although it has two-layer structure, the rigidity of a base 18 may be raised as a three-tiered structure and 4 layer structure, or the laminating of the layer used as a backwiring plate may be carried out to coincidence, and it may be formed in it.

[0171] Next, the actuator section body 30 is formed on the oscillating section 22 of the above-mentioned base 18. In this case, piezo-electricity / electrostriction layer 26 is fabricated by the press-forming method using metal mold, or the tape-forming method using a slurry raw material, a laminating is carried out by thermocompression bonding on the oscillating section 22 in the base 18 before calcinating the piezo-electricity / electrostriction layer 26 before this baking, it calcinates to coincidence, and there are the approach of forming piezo-electricity / electrostriction layer 26 on the oscillating section 22 of a base 18 and the film forming method shown below.

[0172] Although the film forming method is the approach of carrying out the laminating of piezo-electricity / electrostriction layer 26, and the electrode 28 of a pair in this sequence on the oscillating section 22, film methods, such as the applying methods, such as a thick-film method like screen-stencil and dipping, an ion beam, sputtering, vacuum deposition, ion plating, chemical vapor deposition (CVD), and plating, etc. are used suitably, for example. The describing [above] thick-film method and a film method are used also for formation of the wiring 40 and 42 which leads to the electrode 28 of a pair, or a terminal pad.

[0173] The following processes are adopted using the display concerning the gestalt of this operation as the example. First, piezo-electricity / electrostriction layer 26 is formed with screen printing on the oscillating section 22 of a base 18. Then, it calcinates and piezo-electricity / electrostriction layer 26 is joined on the oscillating section 22 of a base 18. In this case, in order to raise the junction nature of a base 18, and the piezo-electricity / electrostriction layer 26 and to make advantageous the unification with these bases 18, and the piezo-electricity / electrostriction layer 26, it is desirable to carry out baking to piezo-electricity / electrostriction layer 26 within a well-closed container under the ambient atmosphere of piezo-electricity / electrostriction layer ingredient. Furthermore, as for ambient atmosphere concentration, it is desirable preferably to make it high.

[0174] Ambient atmosphere baking is performed by the following approach etc.

[0175] (1) Place piezo-electricity / electrostriction layer ingredient, and the powder of this component system into a well-closed container together as an evaporation source.

[0176] (2) Make a lead component superfluous beforehand as a presentation of piezo-electricity / electrostriction layer ingredient.

[0177] (3) Use the plate of piezo-electricity / electrostriction layer ingredient as a setter.

[0178] Moreover, 900-1400 degrees C is desirable still more desirable, and 1100-1400 degrees C of burning temperature are desirable.

[0179] After junction in the above-mentioned base 18, and the piezo-electricity / electrostriction layer 26 is completed, the wiring layer pattern containing the electrode 28 of a pair is formed. This formation is performed by carrying out the laminating of the conductive paste, such as for example, the end of conducting powder, and an organic metal or resinate, by screen-stencil. As the pattern of this wiring layer is shown in drawing 2, it is the pattern of the perpendicular selection line 40, the pattern of a signal line 42, and an electrode pattern, and an

electrode pattern is in not a multi-branch configuration as shown in the shape of spiral shape as shown in drawing 3, or drawing 4 but the condition only made into the circle configuration in this phase (screen-stencil phase).

[0180] Then, by evaporating the necessary part of the electrode pattern of a circle configuration, for example by excimer laser, patterning is carried out to a multi-branch configuration as shown in the shape of spiral shape as shown in drawing 3, or drawing 4, and it considers as the electrodes 28a and 28b of a pair.

[0181] After patterning by the above-mentioned excimer laser is completed, formation of the actuator section body 30 to a base 18 top is completed by heat-treating. In addition, with a film method, when forming the electrodes 28a and 28b of a pair, the above-mentioned heat treatment is not necessarily needed.

[0182] Although connection of the displacement transfer section 32 is made after formation of the actuator section body 30 to the above-mentioned base 18 top is completed In using the ingredient mentioned above as the displacement transfer section 32 the actuator section body 30 and a variation rate -- the variation rate of the ingredient which mentioned above the connection with the transfer section 32 using adhesives -- what is necessary is just to carry out by forming in the upper part of the actuator section body 30 by the approach of coating the solution thru/or slurry of an ingredient which carried out the laminating of the transfer section 32, or was mentioned above

[0183] Then, it is not necessarily required to cut the displacement transfer section 32 so that it may become the same as that of the flat-surface configuration of the actuator section body 30 in general. however, a variation rate -- plate member 32a in the transfer section 32, or a variation rate -- in order to make efficient the variation rate of the actuator section body 30 depending on the quality of the material of transfer member 32b -- a variation rate -- it is desirable to cut the layer of the transfer section 32 or to prepare a notch.

[0184] the variation rate after assembly -- the predetermined distance of the transfer section 32 and the photoconductive corrugated plate 12 -- the variation rate of the actuator section body 30 -- although it cannot be overemphasized that it is necessary to make it small as compared with an amount, it is desirable to prepare the clearance formation member of predetermined magnitude in the part in which the actuator section body 30 does not exist, and to fix closely a fixed part 24 and the photoconductive corrugated plate 12 to it.

[0185] Thus, in the display concerning the gestalt of this operation, as mentioned above, even if it is the case where it is made to apply to a color display method, there is an advantage of not making the number of pixels increase as compared with the case of monochrome screen.

[0186] moreover, the indicating equipment concerning the gestalt of this operation as a configuration of the actuator section body 30 to which the variation rate of the displacement transfer section 32 is carried out alternatively Since the electrode 28 of a pair is formed in one principal plane of the piezo-electricity / electrostriction layer 26 formed on the oscillating section 22 and he is trying to form the electrode 28 of a pair in the 1 principal-plane side of piezo-electricity / electrostriction layer 26 further, The component (as compared with piezo-electricity / electrostriction layer 26, a dielectric constant is very small) of air or the displacement transfer section 32 will intervene between electrode 28a of a pair, and 28b. Therefore, the electrostatic capacity of the actuator section body 30 becomes small as compared with the thing of piezo-electricity / electrostriction layer 26 which formed the electrode up and down, and CR time constant on signal transduction also becomes small in connection with it. That is, it is hard coming to generate a provincial accent in the signal wave form of a voltage signal according to the attribute of a picture signal.

[0187] This is enabled to impress specified voltage to the electrode 28 of the pair in each pixel alternatively, elongation required for each piezo-electricity / electrostriction layer 26 can be given, and it is also controlled in the parts (for example, a screen periphery, a center section, etc.) corresponding to the actuator section 14 allotted to the location distant from the part to which a voltage signal is supplied especially that display brightness becomes weak.

[0188] Namely, it sets to the display concerning the gestalt of this operation. It adds to the advantage of not making the number of pixels increase as compared with the case of monochrome screen, even if it is the case where it is made to apply to a color display method. When it has the advantage that the electrostatic capacity in the actuator section 14 can be reduced and white is displayed all over the display screen, uniform display brightness can be obtained and improvement in image quality can be aimed at.

[0189] In the display especially applied to the gestalt of this operation Since it is considering as the pattern with which while being connected with the perpendicular selection line 40 among the electrodes 28a and 28b of a pair connected electrode 28a to series about one line as shown in drawing 3 and drawing 4, It can become easy to take the large width of face of the periphery part in one [this] electrode 28a (a broken line shows), it can make small wiring resistance of the perpendicular selection line 40 in this case, and can make still smaller CR time constant on signal transduction.

[0190] And it sets to the display concerning the gestalt of this operation. Since the displacement directions of the actuator section body 30 are the drawing 1 top and upward (the direction of the photoconductive corrugated plate 12 side), The displacement transfer section 32 can be forced on the photoconductive corrugated plate 12 with the force of the variation rate of the actuator section body 30. And since it is easy to adjust the clearance (gap) between the

photoconductive corrugated plate 12 and the actuator section 14, it becomes advantageous to ensuring contact to the displacement transfer section 32 and the photoconductive corrugated plate 12.

[0191] Moreover, when [for example,] a part of piezo-electricity / electrostriction layer 26 disappear with some electrodes 28 on it by dielectric breakdown etc. in a manufacture process, While being able to lose futility, such as whole surface remaking, in the middle of a production process only by repairing the electrode 28 which disappeared since it fully functions as the actuator section 14 even if it does not repair piezo-electricity / electrostriction layer 26, improvement in the yield of a display can be made to attain.

[0192] Moreover, in the display concerning the gestalt of this operation, since the oscillating section 22 and a fixed part 24 are formed in one with a base 18 (ceramics), dead air space 20 is formed in the part corresponding to the oscillating section 22 and he is trying for the oscillating section 22 to serve as thin meat, it becomes possible to produce a fixed part 24 and the oscillating section 22 easily to a base 18, and becomes advantageous, when attaining cheap-ization of the manufacturing cost of a display.

[0193] Moreover, since it becomes the form where the heavy-gage fixed part 24 and the oscillating section 22 of thin meat are formed by establishing dead air space 20 in the base 18 which consists of ceramics, the oscillating section 22 can react on the elongation of piezo-electricity / electrostriction layer 26 sensitively, and can be made into the high oscillating section 22 of flattery nature to change of a voltage signal. Moreover, since the rigidity of the boundary part of the oscillating section 22 and a fixed part 24 is fully secured as compared with the actuator section of both **** structure or a cantilever structure, it is hard coming to generate the destruction by the fatigue of the above-mentioned boundary part accompanying vibration of the oscillating section 22. Furthermore, since the rigidity of a base 18 is high, the lamination of the photoconductive corrugated plate 12 and a mechanical component 16 also becomes easy.

[0194] Moreover, it sets to the display concerning the gestalt of this operation. the configuration (the display concerning the display concerning the gestalt of this operation, and the 1st modification -- a circle configuration --) where the angle was able to take each flat-surface configurations of both of dead air space 20, and the piezo-electricity / electrostriction layer 26 Since it considered as elliptical in the display applied to an ellipse configuration and the 4th modification in the display concerning the 2nd and 3rd modifications and magnitude of the flat-surface configuration of dead air space 20 was made more nearly further than that of piezo-electricity / electrostriction layer 26 into size The boundary part of the oscillating section 22 and a fixed part 24 serves as the flat-surface configuration of dead air space 20, and the configuration where the angle was able to be taken similarly, and it is lost that the stress generated by vibration of the oscillating section 22 concentrates locally. And all the peripheries of the oscillating section 22 are supported by the fixed part 24, and can make high rigidity in the periphery part of the oscillating section 22. Consequently, the fatigue limit in the above-mentioned boundary part can be raised sharply, and reinforcement of the actuator section 14, as a result reinforcement of a display can be realized.

[0195] Moreover, it sets to the display concerning the gestalt of this above-mentioned implementation. The electrodes 28a and 28b of a pair mutually the flat-surface configuration on the piezo-electricity / electrostriction layer 26 in the electrodes 28a and 28b of a pair in parallel And since it is considering as the configuration wired by the curled form estranged mutually, If a predetermined electrical potential difference is impressed to the electrodes 28a and 28b of a pair, in one principal plane of piezo-electricity / electrostriction layer 26, electric field will arise at a radial (isotropic), therefore elongation will produce piezo-electricity / electrostriction layer 26 in a radial (isotropic) in one principal plane. At this time, in the deep parts of piezo-electricity / electrostriction layer 26, thereby, elongation smaller than the elongation of a surface part arises in a radial (isotropic), or shrinkage arises in a radial (isotropic), and piezo-electricity / electrostriction layer 26 will be displaced so that that core may serve as a convex efficiently, and moreover, its dispersion on displacement between each pixel also decreases.

[0196] Moreover, like the display applied to the gestalt of the above-mentioned implementation when the flat-surface configuration on the piezo-electricity / electrostriction layer 26 in the electrodes 28a and 28b of a pair is made into a multi-branch configuration, when a predetermined electrical potential difference is impressed to the electrodes 28a and 28b of a pair, in one principal plane, elongation produces piezo-electricity / electrostriction layer 26 in a radial (isotropic). At this time, in the deep parts of piezo-electricity / electrostriction layer 26, it displaces so that that core may serve as a convex from elongation smaller than the elongation of a surface part arising in a radial (isotropic), or shrinkage arising in a radial (isotropic) efficiently, and dispersion on displacement between each pixel also decreases. [when said multi-branch configuration is adopted especially] Since it will be divided into management 52 and 54 and branches 56 and 58, Even if a part of piezo-electricity / electrostriction layer 26 56, for example, a branch, or the part corresponding to 58 disappears with this branch 56 or 58 by dielectric breakdown etc., as long as the effect which it has on others is very small and management 52 and 54 remains, it will fully function as the actuator section 14. Of course, only by repairing the branch 56 of said electrode which disappeared, or 58, it can return to the function before disappearance and simplification of maintenance to a display can be realized.

[0197] Moreover, it sets for the 1st example of operation in the display concerning the gestalt of this operation.

Each actuator section 14 by switching alternatively the condition (alternation electrical-potential-difference impression condition) of impressing an electrical potential difference in alternation to the electrodes 28a and 28b of a pair, and electrical-potential-difference unloaded condition Since the predetermined part of the photoconductive corrugated plate 12 can be made to emit light (namely, an alternation electrical-potential-difference impression condition electrical-potential-difference unloaded condition ON selection, OFF selection), the controllability at the time of changing image information into the driving signal (voltage signal) to the actuator section becomes high, and tends to optimize display drive actuation. Consequently, control of low-power-izing, the improvement in display brightness, a flicker, etc., etc. becomes advantageous also when raising image quality.

[0198] In the 2nd example of operation in the display concerning the gestalt of this operation As the actuator section body 30 is constituted from electrodes 28a and 28b of the pair formed in one principal plane of piezo-electricity / electrostriction layer 26, and this the piezo-electricity / electrostriction layer 26 and it is further shown in drawing 16 B Since it was made to become unsymmetrical focusing on a criteria electric-field point, the displacement property of the actuator section 14 by the impression electric field of 4 times or more of the predetermined electric field between electrode 28a of said pair, and 28b Although the direction of polarization is reversed and it becomes the same as the direction of said electric field in near the front face of piezo-electricity / electrostriction layer 26 since the field strength is large when electric field are applied to hard flow after carrying out polarization processing to piezo-electricity / electrostriction layer 26 Since the field strength of the deep parts of piezo-electricity / electrostriction layer 26 is small, the direction of polarization will be reversed. That is, in said piezo-electricity / electrostriction layer 26, two kinds of polarization will exist and it will function as the actuator section 14 of a false bimorph mold.

[0199] Consequently, near the front face of piezo-electricity / electrostriction layer 26 and the direction of distortion in a deep part become reverse mutually, convex displacement is carried out as a whole in an one direction, and the amount of displacement will become very large according to said false bimorph-operation.

[0200] Especially in the display concerning the gestalt of this operation, a difference arises from the crookedness displacement property serving as an unsymmetrical form in the forward direction and the negative direction of electric field focusing on a criteria electric-field point (point of electric field $E=0$) in each amount of crookedness displacement in two peak value of the electric field which change periodically, for example. Thereby, the amount of relative displacements in electrical-potential-difference unloaded condition and an electrical-potential-difference impression condition and the amount of relative displacements in the condition of having applied the electric field of hard flow mutually become large. Therefore, when it considers as the actuator section 14 arranged per pixel of an indicating equipment, the control to these actuator section 14 becomes easy, and it becomes very advantageous when aiming at improvement in the image quality in an indicating equipment.

[0201] Moreover, when thickness of x (1 micrometer $\leq x \leq 200$ micrometer), and said the piezo-electricity / electrostriction layer 26 is set to y (1 micrometer $\leq y \leq 100$ micrometer) for the distance between electrode 28a of a pair, and 28b, he has the relation of $y=ax$ and is trying to constitute as $1/10 \leq a \leq 100$ in the display concerning the gestalt of this operation.

[0202] In this case, as a displacement property of the actuator section 14 by the impression electric field between electrode 28a of said pair, and 28b, as shown in drawing 16 B, the property which becomes unsymmetrical focusing on a criteria electric-field point (point of electric field $E=0$) can be acquired.

[0203] Moreover, in the display concerning the gestalt of this operation, since said oscillating section 22 and fixed part 24 are formed in one with the ceramics, dead air space 20 is formed in the part corresponding to the oscillating section 22 and it was made for this oscillating section 22 to serve as thin meat, it becomes possible to produce a fixed part 24 and the oscillating section 22 easily, and becomes advantageous, when attaining cheap-ization of the manufacturing cost of a display.

[0204] Moreover, it sets to the display concerning the gestalt of this operation. Since it has the relation of $y=bz$ and was referred to as $1/5 \leq b \leq 10$ when thickness of y (1 micrometer $\leq y \leq 100$ micrometer) and the oscillating section 22 was set to z (1 micrometer $\leq z \leq 50$ micrometer) for the thickness of piezo-electricity / electrostriction layer 26 crookedness of the actuator section 14 by the impression electric field between electrode 28a of a pair, and 28b -- a variation rate -- a property can be made unsymmetrical a core [a criteria electric-field point], as shown in drawing 12 B.

[0205] Especially in the display concerning the gestalt of this operation, although the flat-surface configuration of the electrodes 28a and 28b of a pair was made into the shape of spiral shape, or a multi-branch configuration, as shown in drawing 28, you may be a comb mold configuration. In this case, it is desirable to form the comb mold electrode of a pair so that the configuration of the oscillating section 22 may be made into 0.25 or less and 4.0 or more with an aspect ratio (aspect ratio) and the array direction of many sinking comb parts may meet the longitudinal direction of the oscillating section 22. If this condition is satisfied, even if the electrodes 28a and 28b of a pair are comb mold configurations, the same effectiveness as the shape of said spiral shape or a multi-branch configuration can be acquired.

[0206] However, the configuration of the oscillating section 22 is the most desirable when it enlarges the amount of relative displacements by the aspect ratio 0.25-4.0, and that are 0.5-2.0 preferably and the flat-surface configuration of the electrodes 28a and 28b of a pair considers as the shape of spiral shape and a multi-branch configuration.

[0207] Moreover, although the base 18 was constituted from a layered product of substrate layer 18A, spacer layer 18B, and sheet metal layer 18C as shown in drawing 1, you may make it omit substrate layer 18A of the lowest layer in the display concerning the gestalt of said operation, as shown in drawing 29.

[0208] In the display concerning the display concerning the gestalt of this above-mentioned implementation, and its modification, although that in which both sides had high display flatness and smoothness as the photoconductive corrugated plate 12 was used, a tooth-back side is able to use the so-called obscured glass by which surface roughening was carried out. In this case, surface roughening in alignment with a split-face configuration [in / for one principal plane (field which counters the tooth back of an obscured glass) of the displacement transfer section 32 / the tooth back of an obscured glass] is performed, or viscosity constitutes the displacement transfer section 32 top Norikazu principal plane part from a comparatively low elastomer.

[0209] Thereby, first, it is reflected by the split face of an obscured glass and the light which carried out incidence from the transverse plane penetrates in the direction of a front face of an obscured glass as the scattered light. If the displacement transfer section 32 corresponding to the above-mentioned actuator section 14 contacts the tooth back of an obscured glass in this condition, a certain actuator section 14 being used as an electrical-potential-difference impression condition or ON selection condition Since the split face of the contact part concerned serves as a form negated by the split face or elastic deformation of the displacement transfer section 32, the light which was being reflected in the above-mentioned split-face part of an obscured glass till then will penetrate the displacement transfer section 32 in contact with the tooth back of an obscured glass.

[0210] that is, the variation rate which is in the tooth back of an obscured glass also when an obscured glass is used as a photoconductive corrugated plate 12 -- the existence of luminescence of the light in the front face of an obscured glass can be controlled by existence of contact of the transfer section 32, and the same effectiveness as the display concerning the gestalt of this operation mentioned above or the display concerning the modification can be acquired by it. Since the lighting means into which light is made to introduce positively to an obscured glass becomes unnecessary especially when the above-mentioned obscured glass is used, a configuration is simplified more.

[0211] In addition, although the display concerning this invention has been concretely explained to the display list concerning the gestalt of this operation based on the display concerning the 1st - the 4th modification, this invention can add modification which becomes various, correction, amelioration, etc., unless it is limited to a modification by the gestalt list of the above-mentioned implementation, and is not interpreted and it deviates from the range of this invention.

[0212]

[Effect of the Invention] The photoconductive corrugated plate into which light is introduced according to the display concerning this invention as explained above, The mechanical component by which it was countered and prepared in one plate surface of this photoconductive corrugated plate, and the actuator section of the number corresponding to many pixels was arranged is provided. By controlling displacement actuation of the contact / isolation direction of said actuator section to said photoconductive corrugated plate according to the attribute of the picture signal inputted, and controlling the leakage light of the predetermined part of said photoconductive corrugated plate In the display which displays the image according to said picture signal on said photoconductive corrugated plate The actuator section body which has the electrode of the pair formed in one principal plane of piezo-electricity / electrostriction layer, and this piezo-electricity / electrostriction layer in said actuator section, The oscillating section which supports said actuator section body in contact with the other principal planes of said piezo-electricity / electrostriction layer, He is trying to prepare in the fixed part which supports said oscillating section possible [vibration], and the displacement transfer section which transmits displacement actuation of the actuator section body produced by electrical-potential-difference impression to the electrode of said pair to a photoconductive corrugated plate.

[0213] For this reason, even if it is the case where it is made to apply to a color display method, when it has the advantage that the electrostatic capacity in the actuator section can be reduced in addition to the advantage of not making the number of pixels increase as compared with the case of monochrome screen and white is displayed all over the display screen, uniform display brightness can be obtained and the effectiveness that improvement in image quality can be aimed at is attained.

[0214] crookedness of said actuator section by the impression electric field of 4 times or more of the especially inter-electrode predetermined electric field of said pair -- a variation rate -- the amount of relative displacements in electrical-potential-difference unloaded condition and an electrical-potential-difference impression condition and the amount of relative displacements in the condition of having applied the electric field of hard flow mutually become large by making a property unsymmetrical a core [a criteria electric-field point].

[0215] It becomes very advantageous, when the control to the actuator section arranged per pixel of an indicating equipment becomes easy and improvement in the image quality in an indicating equipment is aimed at from this.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing the display concerning the gestalt of this operation.

[Drawing 2] It is the top view expanding and showing arrangement of the actuator section (pixel) in the indicating equipment concerning the gestalt of this operation.

[Drawing 3] They are a display concerning the gestalt of this operation, especially the top view showing the flat-surface configuration (curled form) of the electrode of a pair.

[Drawing 4] It is the top view showing the 1st modification of the display concerning the gestalt of this operation, especially the flat-surface configuration (multi-branch configuration) of the electrode of a pair.

[Drawing 5] It is the top view showing the 2nd modification of the display concerning the gestalt of this operation especially the oscillating section, piezo-electricity / electrostriction layer, and the flat-surface configuration (an ellipse configuration, curled form) of the electrode of a pair.

[Drawing 6] It is the top view showing the 3rd modification of the display concerning the gestalt of this operation especially the oscillating section, piezo-electricity / electrostriction layer, and the flat-surface configuration (an ellipse configuration, multi-branch configuration) of the electrode of a pair.

[Drawing 7] It is the top view expanding and showing arrangement of the actuator section (pixel) in the 4th modification of the indicating equipment concerning the gestalt of this operation.

[Drawing 8] It is the top view expanding and showing arrangement of the actuator section (pixel) in the 5th modification of the indicating equipment concerning the gestalt of this operation.

[Drawing 9] It is the top view expanding and showing arrangement of the actuator section (pixel) in the 6th modification of the indicating equipment concerning the gestalt of this operation.

[Drawing 10] It is the top view showing roughly the case where the piezo-electricity / electrostriction layer of the actuator section in the indicating equipment concerning the gestalt of this operation are made into the shape of a ring.

[Drawing 11] It is a sectional view on the A-A line in drawing 10.

[Drawing 12] In the actuator section in the indicating equipment concerning the gestalt of this operation, it is the top view showing the example which made the flat-surface configuration of piezo-electricity / electrostriction layer in a circle, and made the electrode of a pair the multi-branch configuration.

[Drawing 13] Drawing 13 A is the top view showing the case where the periphery configuration of ring-like piezo-electricity / electrostriction layer is made circular, drawing 13 B is the top view showing the case where the periphery configuration of ring-like piezo-electricity / electrostriction layer is made into an ellipse form, and drawing 13 C is the top view showing the case where the periphery configuration of ring-like piezo-electricity / electrostriction layer is made into a rectangle.

[Drawing 14] It is the operation Fig. showing the displacement principle of the actuator section in the 1st example of operation in the indicating equipment concerning the gestalt of this operation.

[Drawing 15] When the actuator section of the indicating equipment concerning the gestalt of this operation is made into ON selection condition, it is the signal waveform diagram showing an example of the alternation signal impressed to inter-electrode [of a pair].

[Drawing 16] crookedness of the actuator section in the indicating equipment which drawing 16 A requires for the gestalt of this operation -- a variation rate -- the timing chart which shows the potential wave which should be impressed to the electrode of a pair in order to measure a property -- it is -- drawing 16 B -- crookedness of the actuator section -- a variation rate -- it is the property Fig. showing a property.

[Drawing 17] Drawing 17 A is the explanatory view showing the direction of polarization and the direction of electric field of [at the time of performing initial polarization processing to piezo-electricity / electrostriction layer], and drawing 17 B is the explanatory view showing the direction of polarization in the condition (electrical-potential-difference unloaded condition) of having stopped the electrical-potential-difference impression to the electrode of a pair.

[Drawing 18] Drawing 18 A is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied electric field (+3E) in the forward direction to the actuator section of the indicating equipment concerning the gestalt of this operation, and drawing 18 B is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied the predetermined electric field (- 0.6E) of the negative direction to the actuator section.

[Drawing 19] Drawing 19 A is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied electric field (- 3E) in the negative direction to the actuator section of the indicating equipment concerning the gestalt of this operation, and drawing 19 B is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied the predetermined electric field (+0.6E) of the forward direction to the actuator section.

[Drawing 20] It is the property Fig. showing the dimension relation of the inter-electrode distance of the pair of each actuator section and the thickness of piezo-electricity / electrostriction layer in the indicating equipment concerning the gestalt of this operation.

[Drawing 21] Drawing 21 A is the explanatory view showing inter-electrode distance in case the flat-surface configuration of the electrode of a pair is a curled form, and drawing 21 B is the explanatory view showing inter-electrode distance in case the flat-surface configuration of the electrode of a pair is a multi-branch configuration.

[Drawing 22] It is the property Fig. showing the dimension relation of the thickness of the oscillating section of each actuator section and the thickness of piezo-electricity / electrostriction layer in the indicating equipment concerning the gestalt of this operation.

[Drawing 23] Drawing 23 A is the sectional view omitting and showing a part of cross-section configuration in the shortest dimension of the actuator section, drawing 23 B is the sectional view omitting and showing a part of case where one outermost minimum point and the outermost minimum point of another side exist caudad rather than the top face of a fixed part, and drawing 23 C is the sectional view omitting and showing a part of case where one outermost minimum point and the outermost minimum point of another side exist more nearly up than the top face of a fixed part.

[Drawing 24] As for drawing 24 A, the outermost minimum point of another side does not exist in the minimum point existence region of another side. It is the sectional view omitting and showing a part of example in case the boundary point of another side is authorized as the outermost minimum point of another side. Drawing 24 B is the sectional view omitting and showing a part of example in the case of the outermost minimum point not existing in both minimum point existence regions, respectively, but being recognized as the outermost minimum point that one boundary point and the boundary point of another side are one side, respectively, and the outermost minimum point of another side.

[Drawing 25] Drawing 25 A is a timing chart which shows change of the voltage level in the condition of not choosing and ON selection condition in the actuator section, and drawing 25 B is a timing chart which shows change of the voltage level in the condition of not choosing and OFF selection condition in the actuator section.

[Drawing 26] Drawing 26 A is a timing chart at the time of setting the ratio of the luminescence time amount of RGB in the case of applying the display concerning the gestalt of this operation to a color display method to 1:1:1, and drawing 26 B is a timing chart at the time of setting the ratio of the luminescence time amount of said RGB to 4:1:5.

[Drawing 27] It is the perspective view seeing and showing the large screen display by the display concerning the gestalt of this operation from a tooth-back side.

[Drawing 28] It is the top view showing the suitable example at the time of making the flat-surface configuration of the electrode of the pair of the actuator section in the indicating equipment concerning the gestalt of this operation into a comb mold configuration.

[Drawing 29] In the display concerning the gestalt of this operation, it is the block diagram showing other examples of structure of a base.

[Drawing 30] It is the block diagram showing the display concerning the example of a proposal.

[Drawing 31] crookedness of the actuator section in the indicating equipment which drawing 31 A requires for the example of a proposal -- a variation rate -- the timing chart which shows the potential wave which should be impressed to an up electrode and a lower electrode in order to measure a property -- it is -- drawing 31 B -- crookedness of the actuator section -- a variation rate -- it is the property Fig. showing a property.

[Drawing 32] Drawing 32 A is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied electric field (+3E) in the forward direction to the actuator section of the indicating equipment concerning the example of a proposal, and drawing 32 B is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied the predetermined electric field (- 0.5E) of the negative direction to the actuator section.

[Drawing 33] Drawing 33 A is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied electric field (- 3E) in the negative direction to the actuator section

of the indicating equipment concerning the example of a proposal, and drawing 33 B is the explanatory view showing the direction of polarization and the direction of electric field of the condition of having applied the predetermined electric field (+0.5E) of the forward direction to the actuator section.

[Description of Notations]

- 10 -- Light 12 -- Photoconductive corrugated plate
- 14 -- Actuator section 16 -- Mechanical component
- 18 -- Base 20 -- Dead air space
- 22 -- Oscillating section 24 -- Fixed part
- 26 -- Piezo-electricity / electrostriction layer 28 -- Electrode of a pair
- 28a -- One electrode 28b -- Electrode of another side
- 30 -- Actuator section body 32 -- Displacement transfer section
- 32a -- Plate member 32b -- Displacement transfer member
- 40 -- Perpendicular selection line 42 -- Signal line
- 44 46 -- Through hole

[Translation done.]

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DRAWINGS

[Drawing 1]

FIG.1

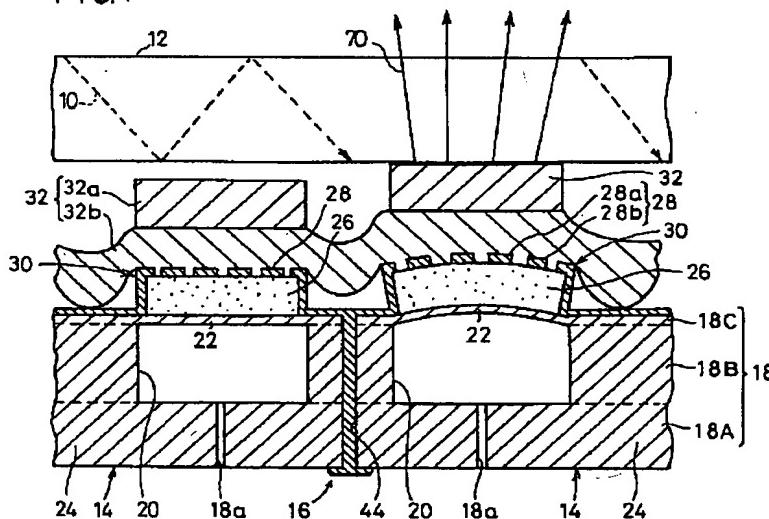
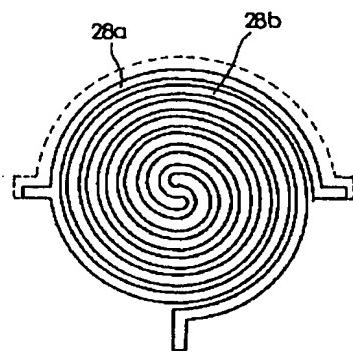
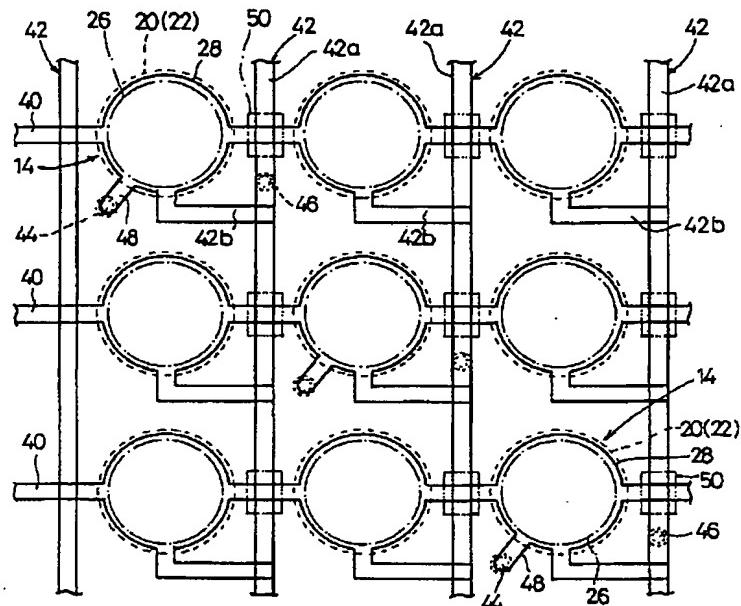
[Drawing 3]

FIG. 3

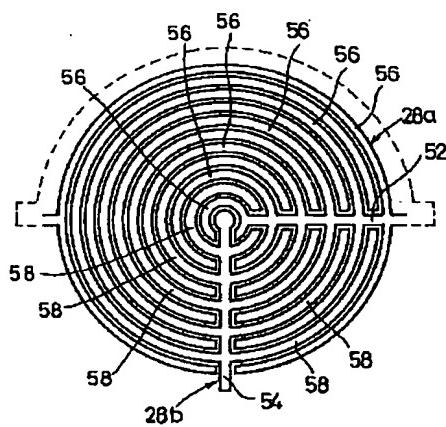
[Drawing 2]

"FIG. 2"



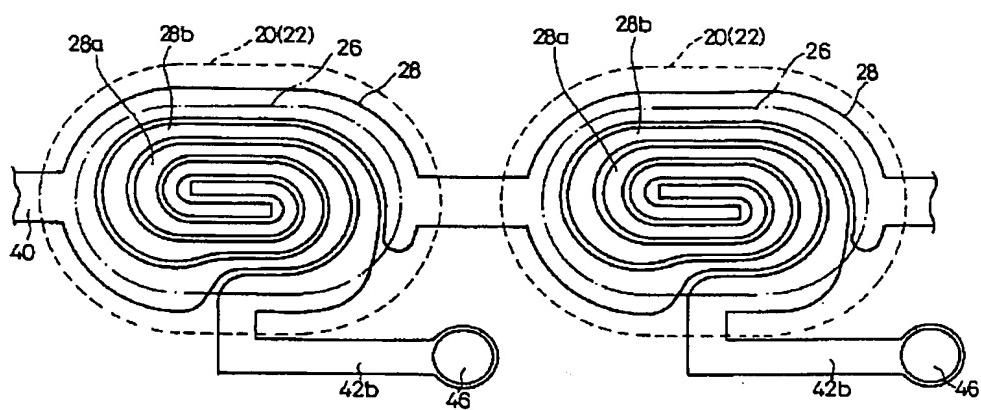
[Drawing 4]

FIG.4



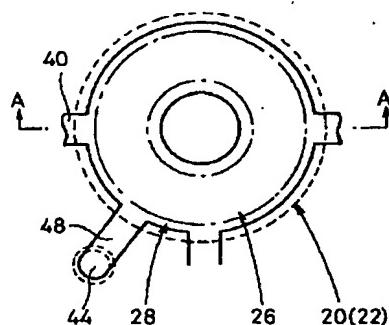
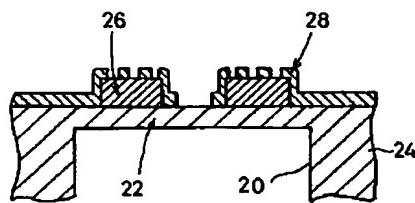
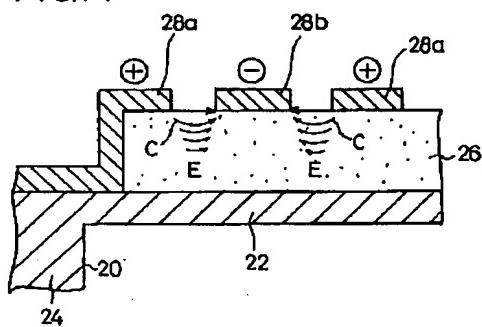
[Drawing 5]

FIG. 5



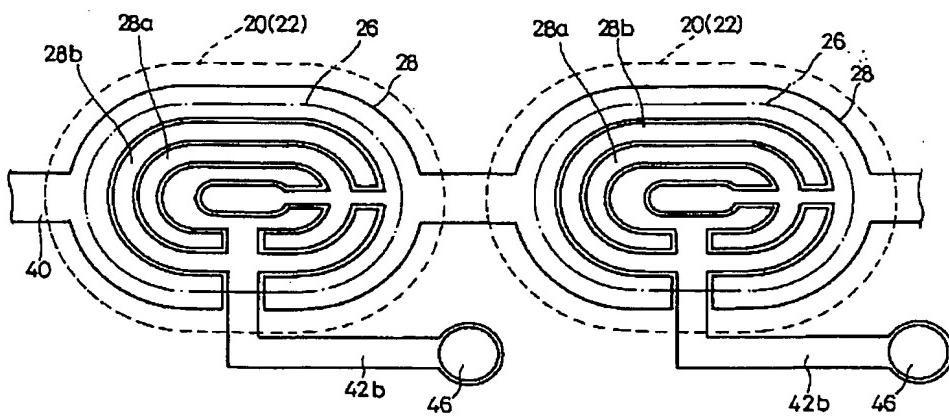
[Drawing 10]

FIG.10

[Drawing 11]
FIG.11[Drawing 14]
FIG.14

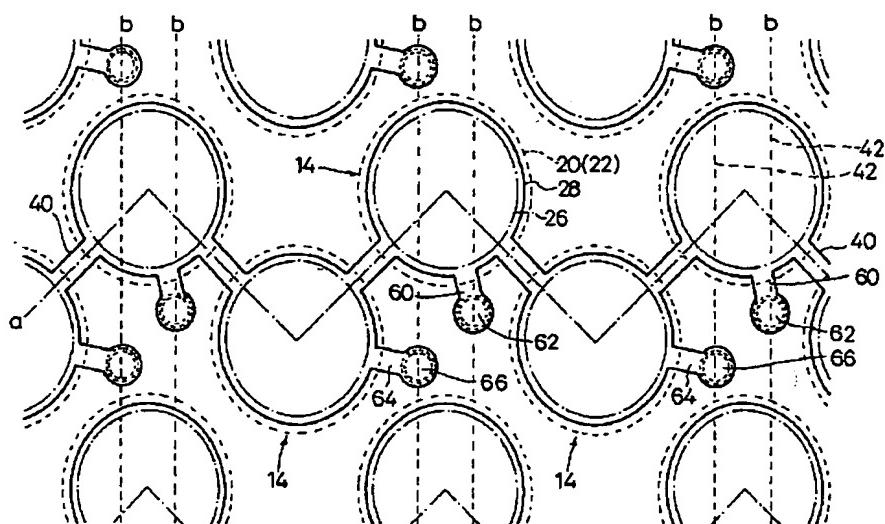
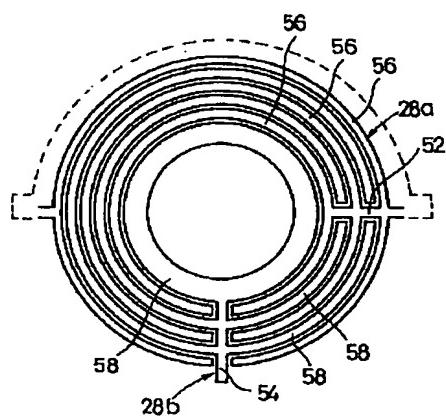
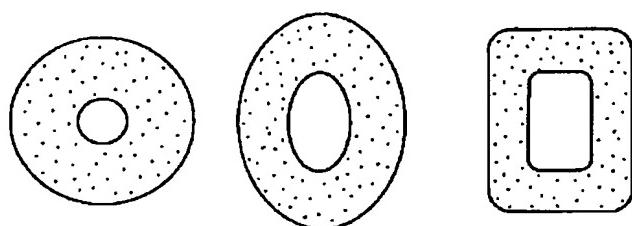
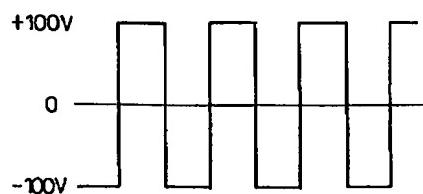
[Drawing 6]

FIG. 6



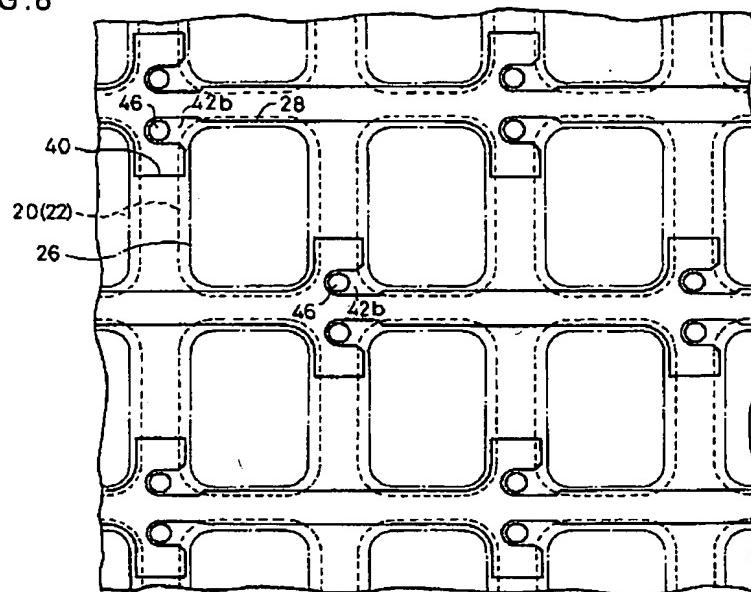
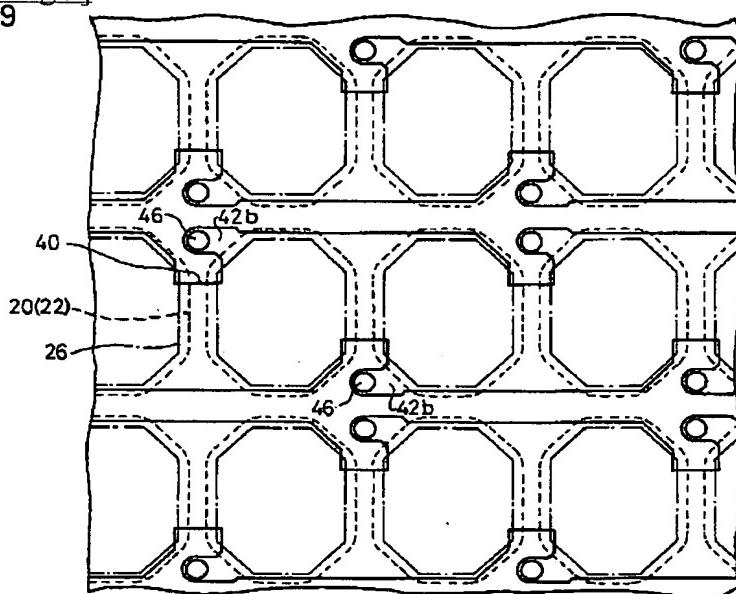
[Drawing 7]

FIG. 7

[Drawing 12]
FIG.12[Drawing 13]
FIG.13A FIG.13B FIG.13C[Drawing 15]
FIG.15

[Drawing 8]

FIG.8

[Drawing 9]
FIG.9

[Drawing 23]

FIG.23A

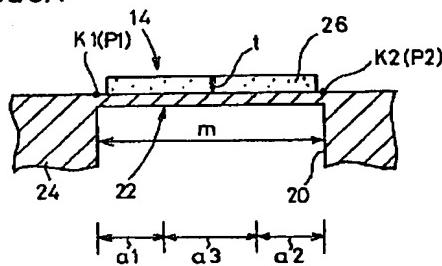


FIG.23B

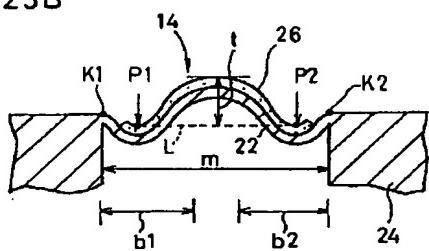
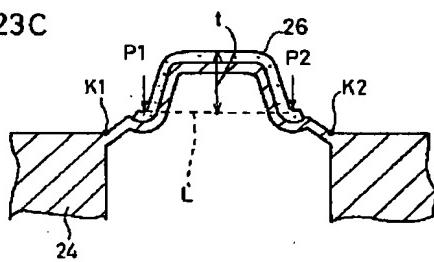
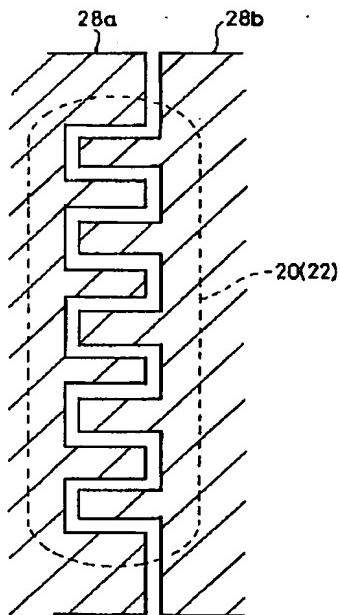


FIG.23C



[Drawing 28]

FIG.28



[Drawing 16]

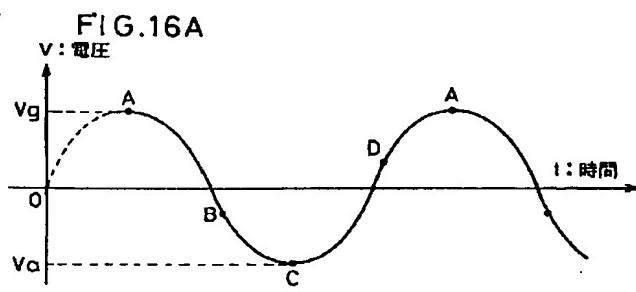
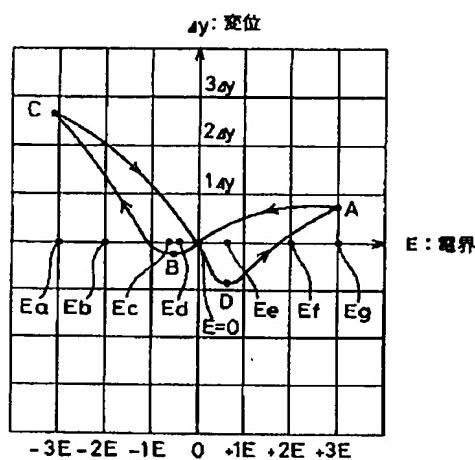
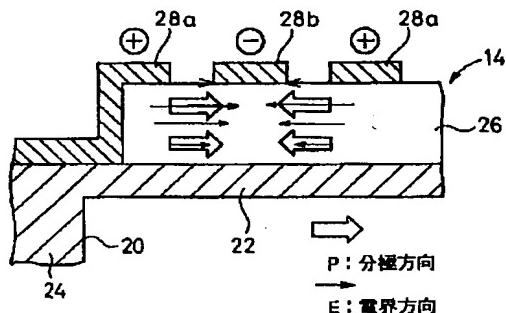
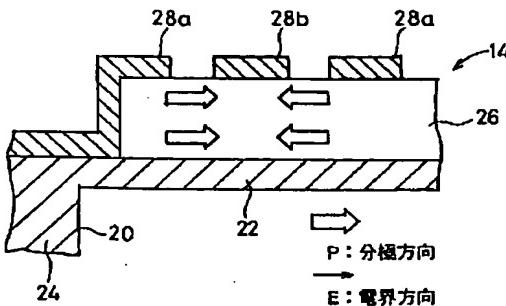
**FIG.16B****[Drawing 17]****FIG.17A****FIG.17B****[Drawing 20]**

FIG.20

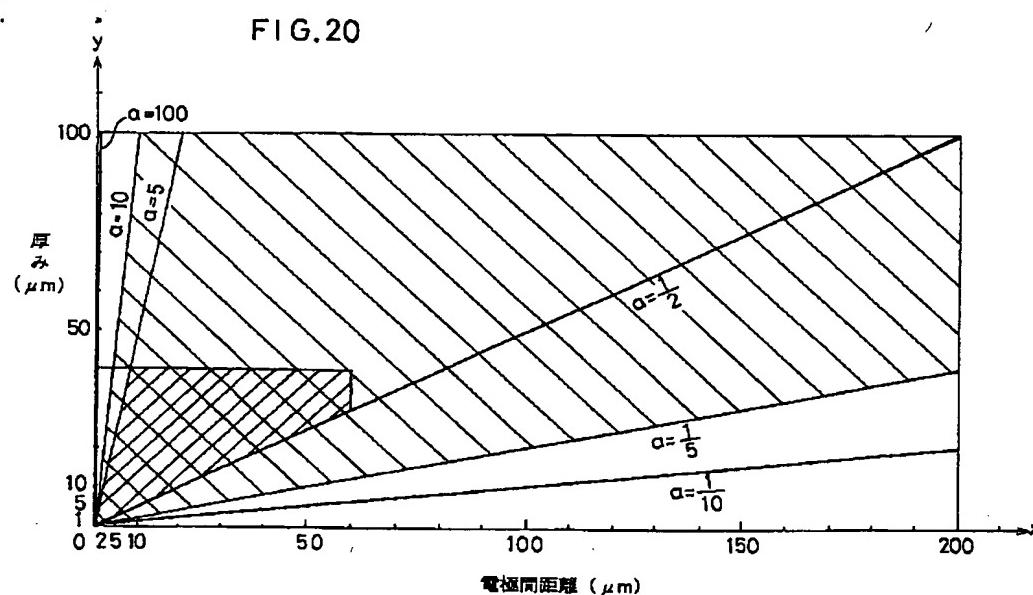
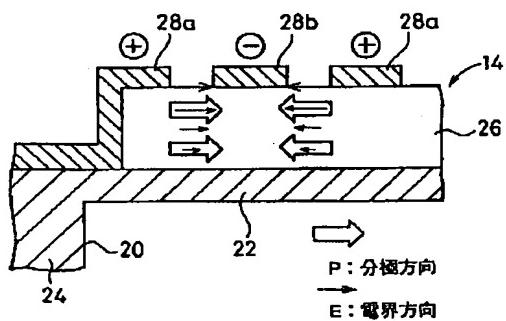
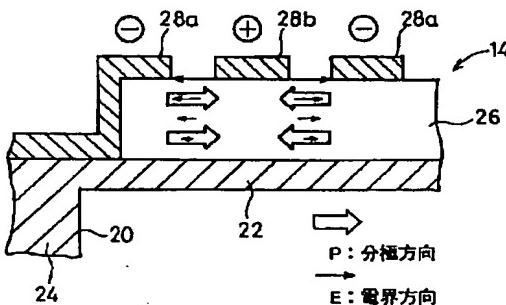
[Drawing 18]
FIG.18A

FIG.18B



[Drawing 19]

FIG.19A

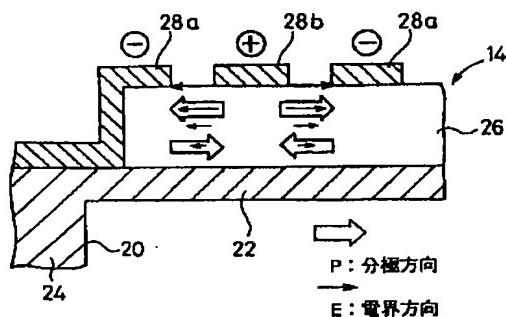
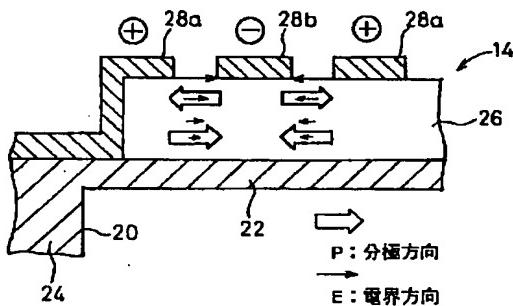


FIG.19B



[Drawing 21]

FIG.21A

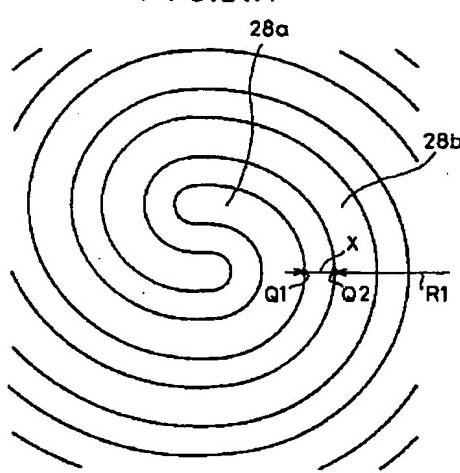
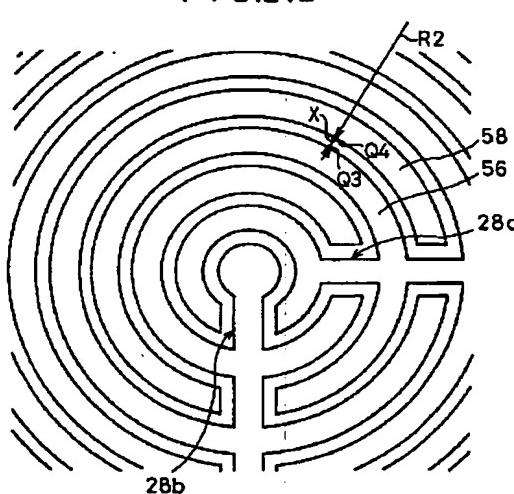


FIG.21B



[Drawing 22]

FIG.22

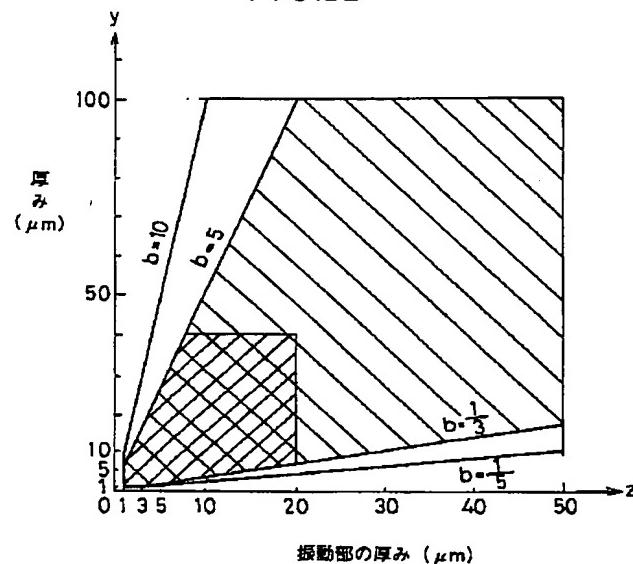
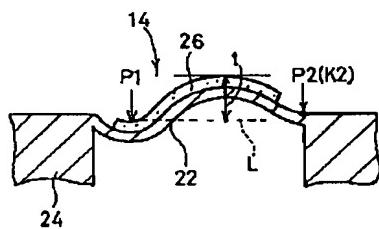
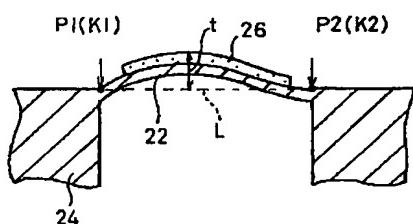
[Drawing 24]
FIG.24A

FIG.24B



[Drawing 25]

FIG.25A

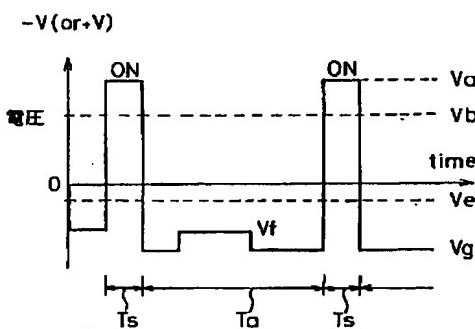
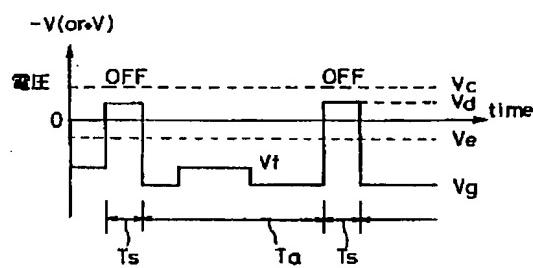


FIG.25B



[Drawing 26]
FIG.26A

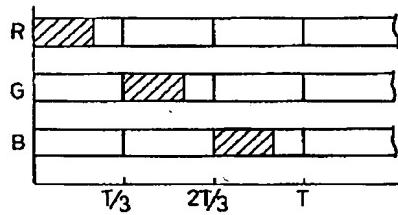
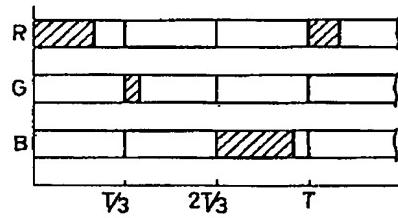
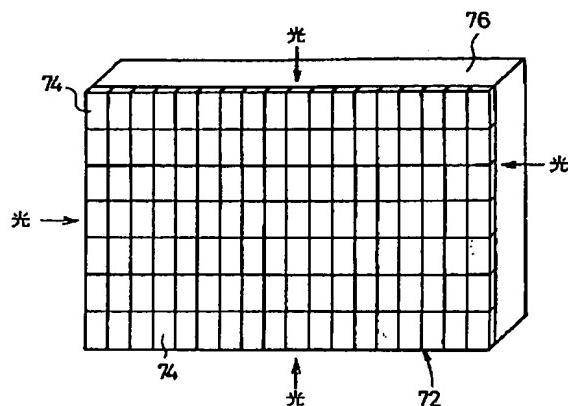


FIG.26B



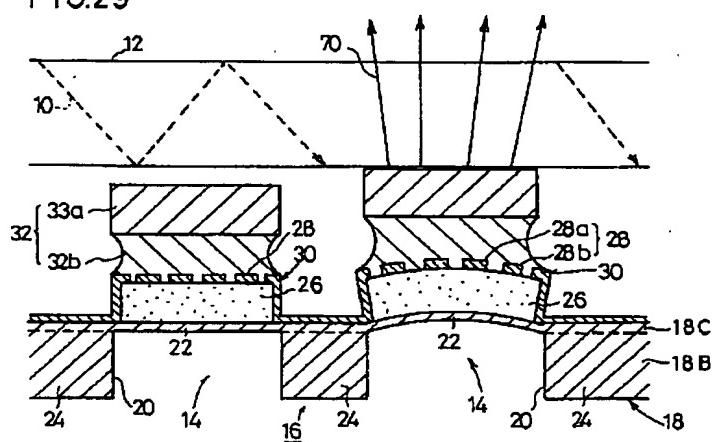
[Drawing 27]

FIG.27



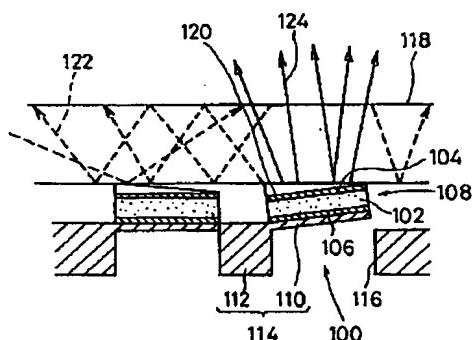
[Drawing 29]

FIG.29



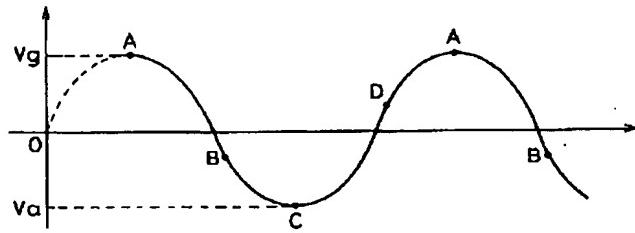
[Drawing 30]

FIG.30



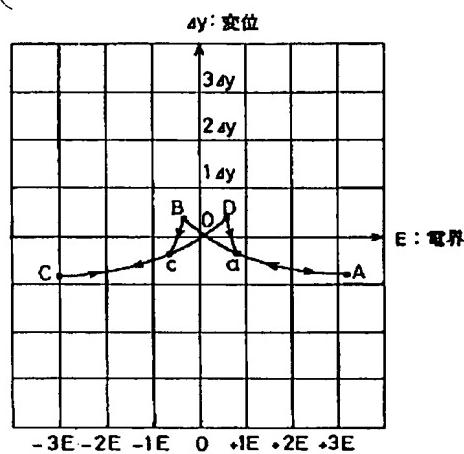
[Drawing 31]

FIG.31A



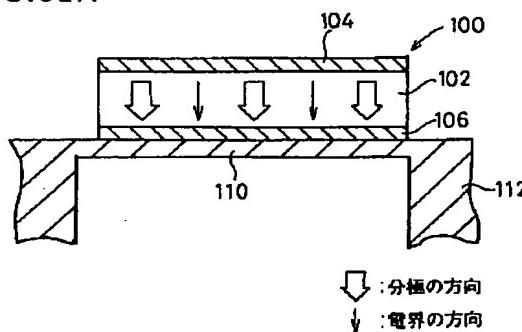
V_a : 電界 $E_a(-3E)$ を与える電圧
 V_g : 電界 $E_g(+3E)$ を与える電圧

FIG.31B



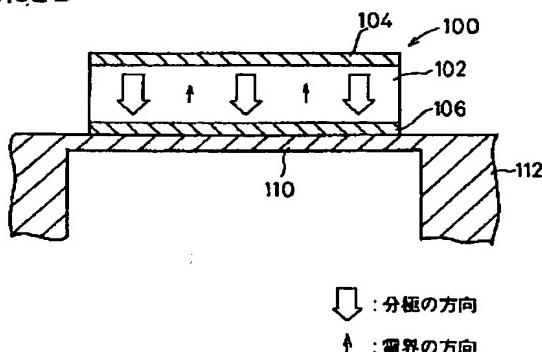
[Drawing 32]

FIG.32A



↓ : 分極の方向
↓ : 電界の方向

FIG.32B



↓ : 分極の方向
↑ : 電界の方向

[Drawing 33]

FIG.33A

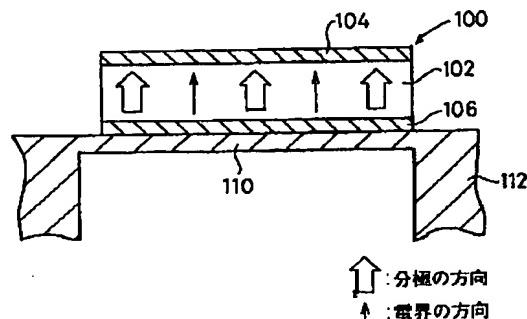
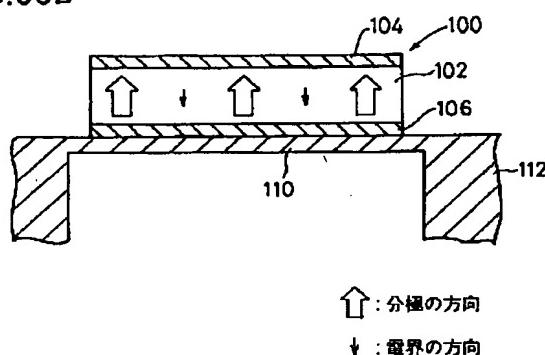


FIG.33B



[Translation done.]

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law

[Section partition] The 2nd partition of the 6th section

[Publication date] November 30, Heisei 13 (2001. 11.30)

[Publication No.] JP,10-78549,A

[Date of Publication] March 24, Heisei 10 (1998. 3.24)

[Annual volume number] Open patent official report 10-786

[Application number] Japanese Patent Application No. 8-335876

[The 7th edition of International Patent Classification]

G02B 26/08

G09F 9/30

[FI]

G02B 26/08 A

G09F 9/30

[Procedure revision]

[Filing Date] April 25, Heisei 13 (2001. 4.25)

[Procedure amendment 1]

[Document to be Amended] Specification

[Item(s) to be Amended] 0164

[Method of Amendment] Modification

[Proposed Amendment]

[0164] As for displacement transfer member 32b of the displacement transfer section 32, what has the degree of hardness of extent which can transmit the variation rate of the actuator section 14 to the direct photoconductive corrugated plate 12 is desirable. Therefore, although rubber, organic resin, an organic adhesive film, glass, etc. are mentioned as a desirable thing as the quality of the material of the above-mentioned displacement transfer member 32b, you may be the quality of the material of the electrode layer itself, a piezo electric crystal, or the ceramics mentioned above. Organic resin or organic adhesive films, such as an epoxy system, acrylic, a silicone system, and a polyolefine system, are good most preferably. Furthermore, it is also effective to mix a filler with these and to control hardening contraction.

[Translation done.]